

US EPA ARCHIVE DOCUMENT



# Yolo County Full-Scale Landfill Bioreactor (EPA Project XL)



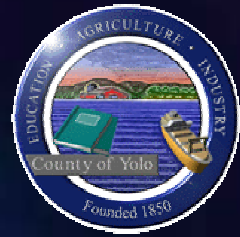
US EPA Workshop on  
Bioreactor Landfills  
February 27-28, 2003  
Ramin Yazdani, Project Manager

Yolo County

Planning and Public Works Department  
Division of Integrated Waste Management

Phone (530) 666-8848; [Ramin.Yazdani@Yolocounty.org](mailto:Ramin.Yazdani@Yolocounty.org)



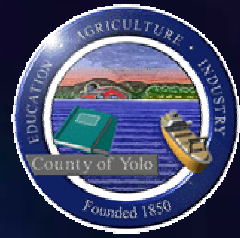


# Presentation Summary

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- Project Objectives and Goals
- Achievements to Date
- Project Results
- Project Challenges
- Conclusions





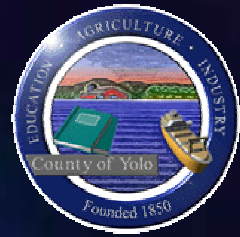
# Project Partners



## ■ Project Partners:

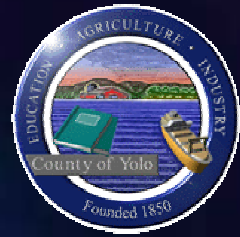
- California Integrated Waste Management Board
- California Energy Commission-PIER
- National Energy Technology Laboratory, U.S. DOE
- Western Regional Biomass Energy Program, U.S. DOE
- Institute for Environmental Management (Tech. Support)
- U.S. Environmental Protection Agency
- Solid Waste Association of North America
- California State Regional Water Quality Control Board
- California State Water Resources Control Board
- California Air Resources Control Board
- Yolo-Solano Air Quality Management District
- Yolo County Environmental Health





# Project Objectives

- Demonstrate landfill full-scale operation to accelerate methane generation (anaerobic) and eliminate methane production (aerobic) through liquid addition without significant liquid head build up over the base liner
- Document and provide project technical data to regulatory agencies for permitting an acceptance of full-scale bioreactor operation (EPA project XL)
- Improve methane gas efficiency capture of nearly all methane generated without impact to air quality
- Determine cost benefit ratio for full-scale operation

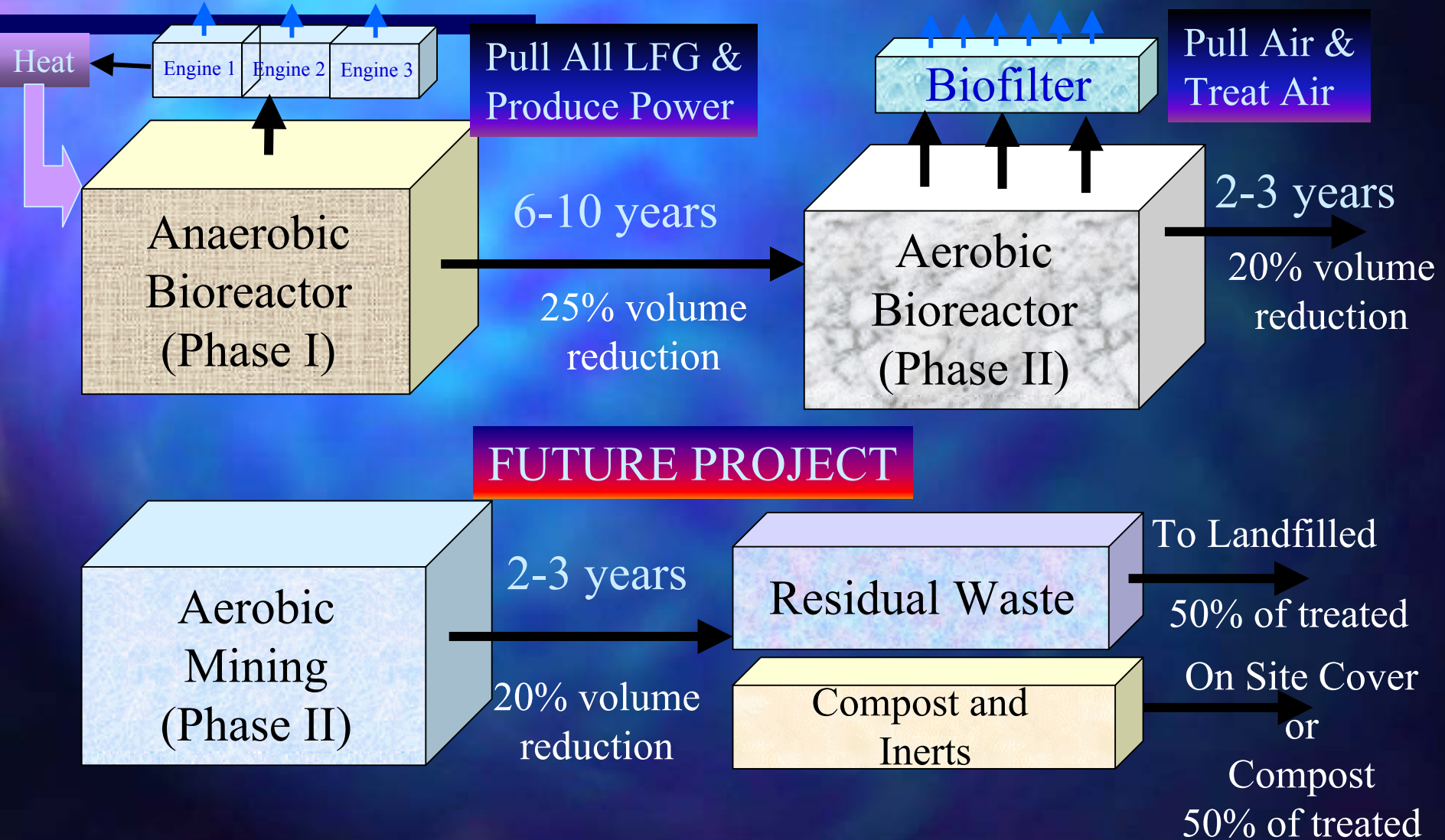


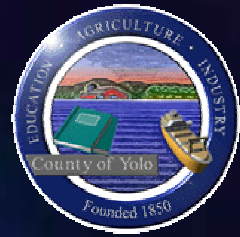
# Project Goals

- Instrument landfill to collect and analyze:
  - Landfill gas volumetric flow, temp., composition
  - Landfill leachate volumes, temp., pH, chemistry
  - Landfill waste temp., moisture content & settlement
  - Measure liquid level above the landfill base liner
  - Parasitic energy use for operation
- Develop mass balance and model leachate and methane gas generation over time
- Develop cost benefit ratio for the project



# Anaerobic & Aerobic Process for Treatment of Waste



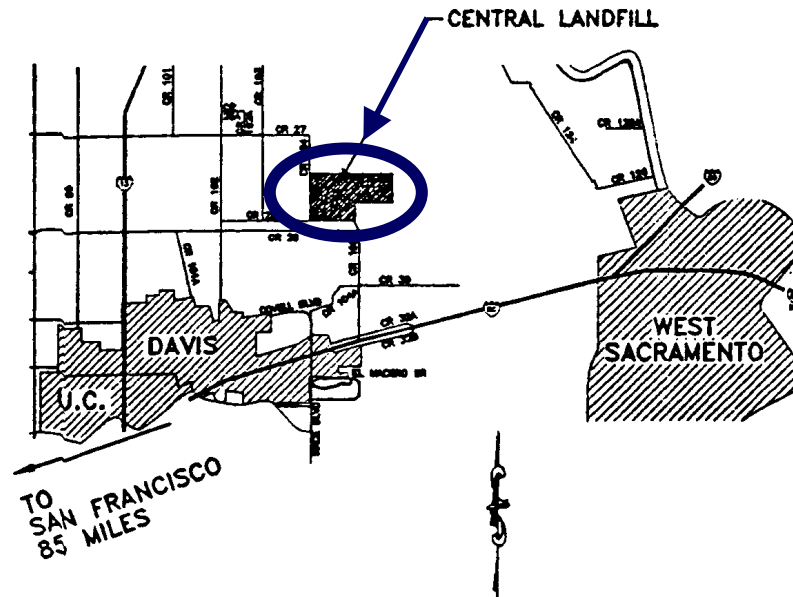


# Project Location Map

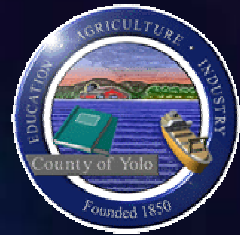
## California



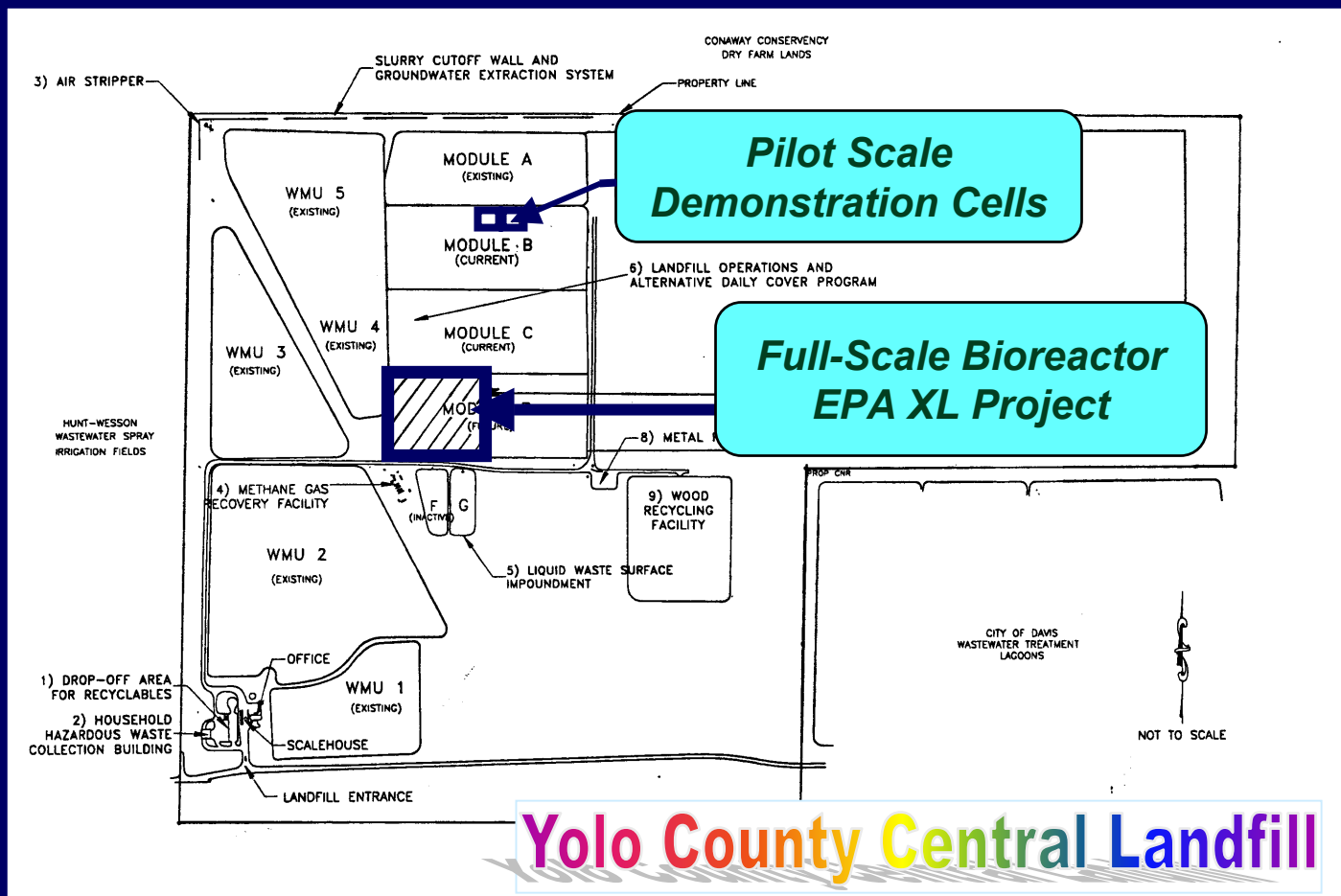
## Woodland

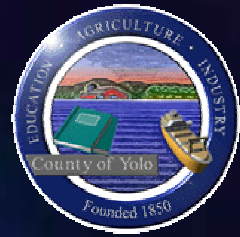






# Project Site Map

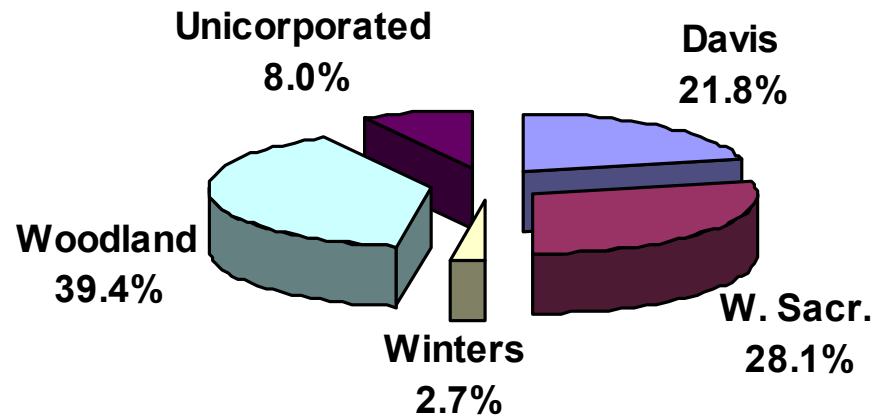


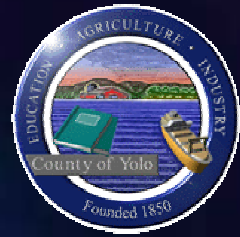


# Project Summary

## Yolo County Waste Percent by Weight

(44% Residential, 42% Commercial, 14% Industrial)





# Full-Scale Project Site Map

**12 Acres**

*Anaerobic  
Cell*  
**6 Acres**

*Anaerobic  
Cell*  
**3.5 Acres**

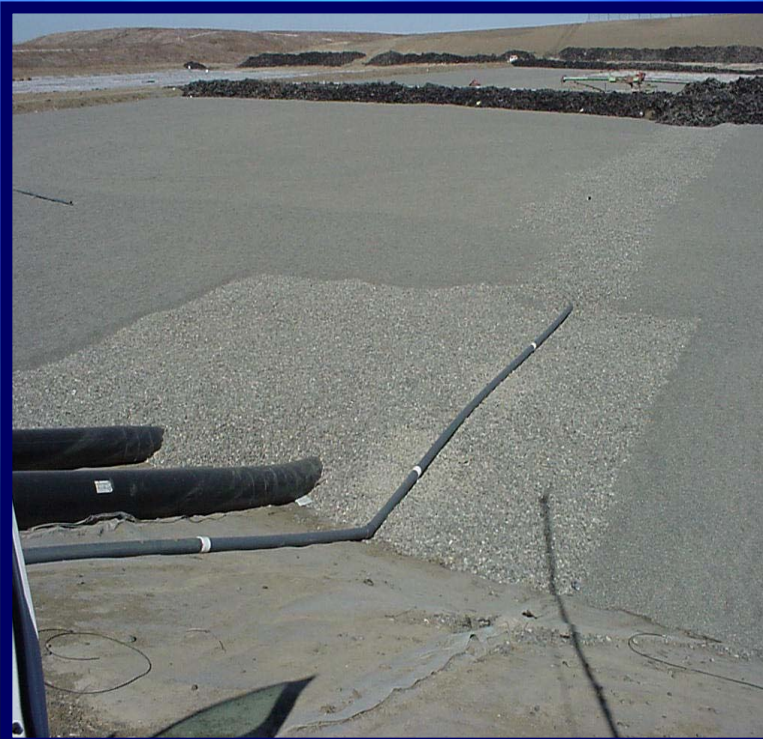
*Aerobic Cell*  
**2.5 Acres**





# Achievements to Date

- Construction of base liner system







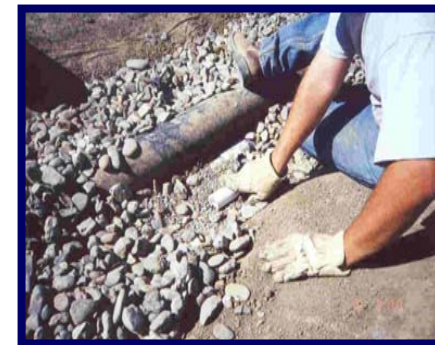
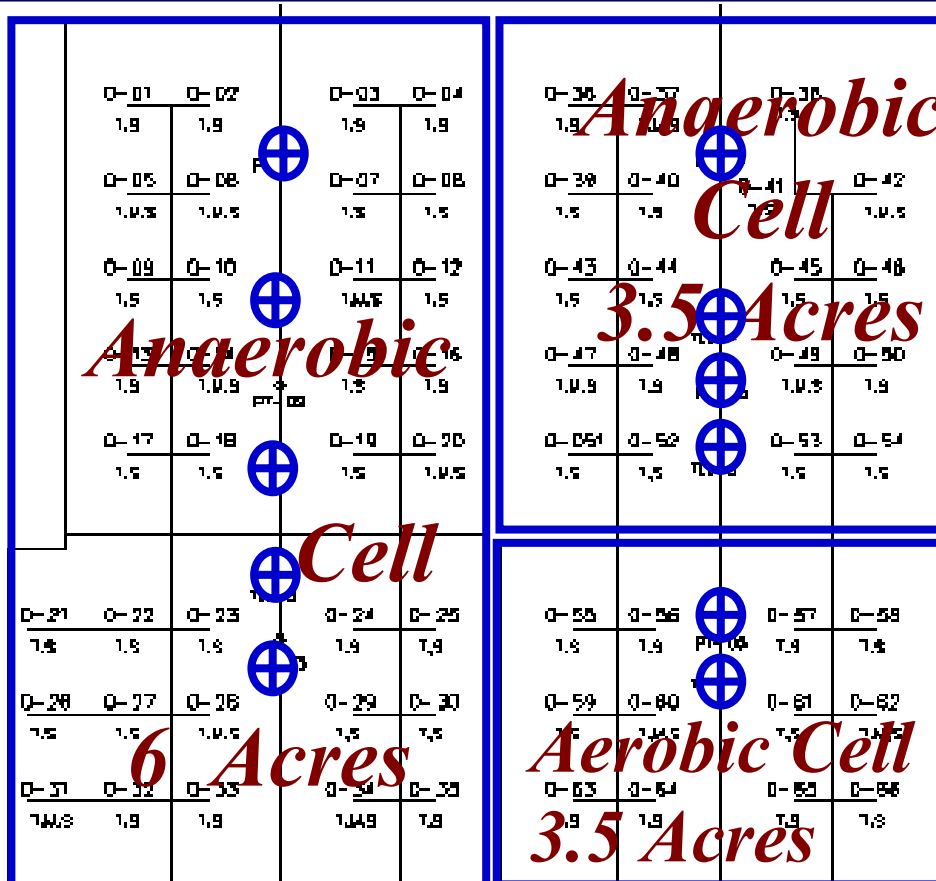
# Achievements to Date

## ■ Construction of landfill waste filling



# Achievements to Date

## •Base Layer Instrumentation



LEGEND

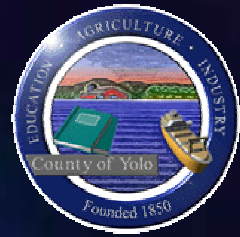
- ⊕ PT = Pressure Transducer
- ⊕ TLL = Trench Liquid Level Tube
- ⊕ T = Temperature Sensor
- ⊕ M = PVC Moisture Sensor
- ⊕ S = Sampling Tubes



# Achievements to Date

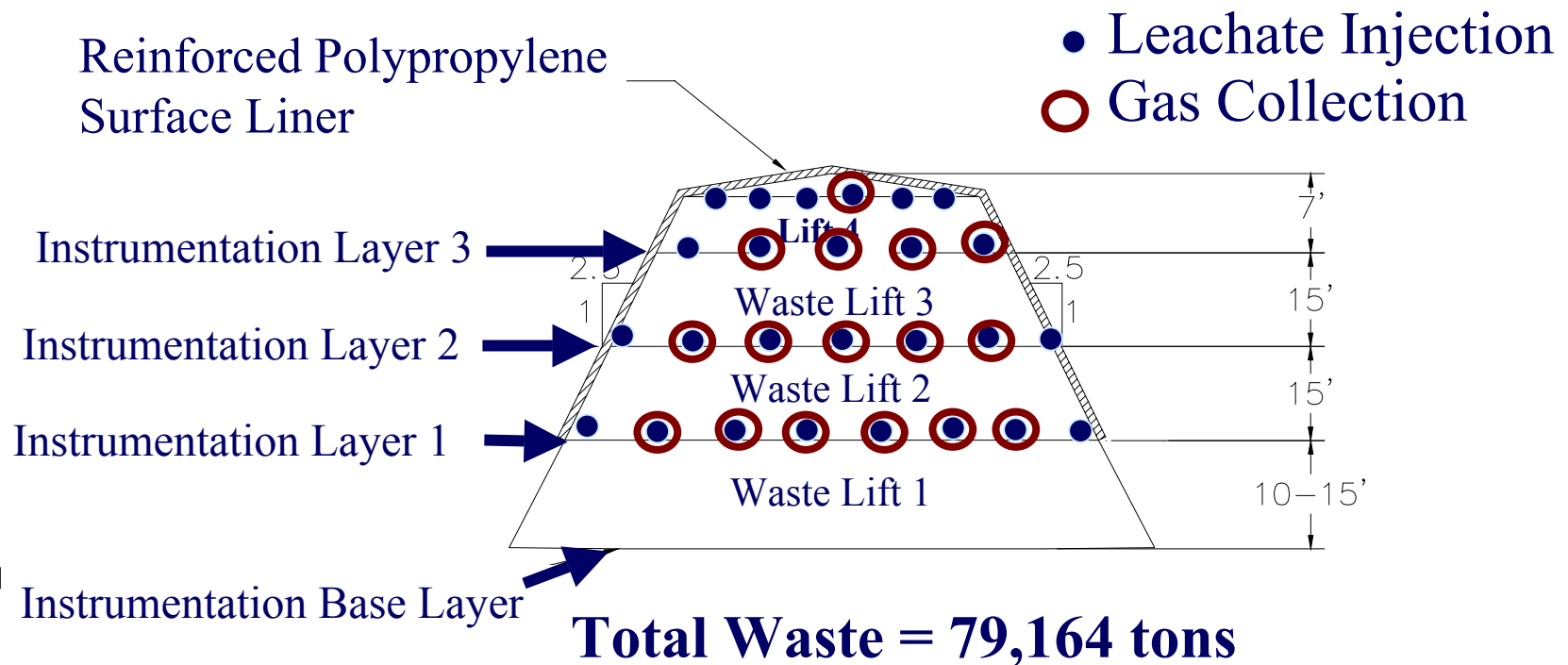
- Construction of the instrumentation system (Temperature, Moisture, Tubes)

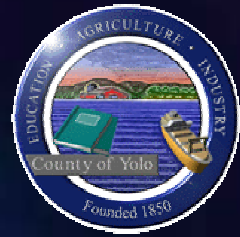




# Achievements to Date

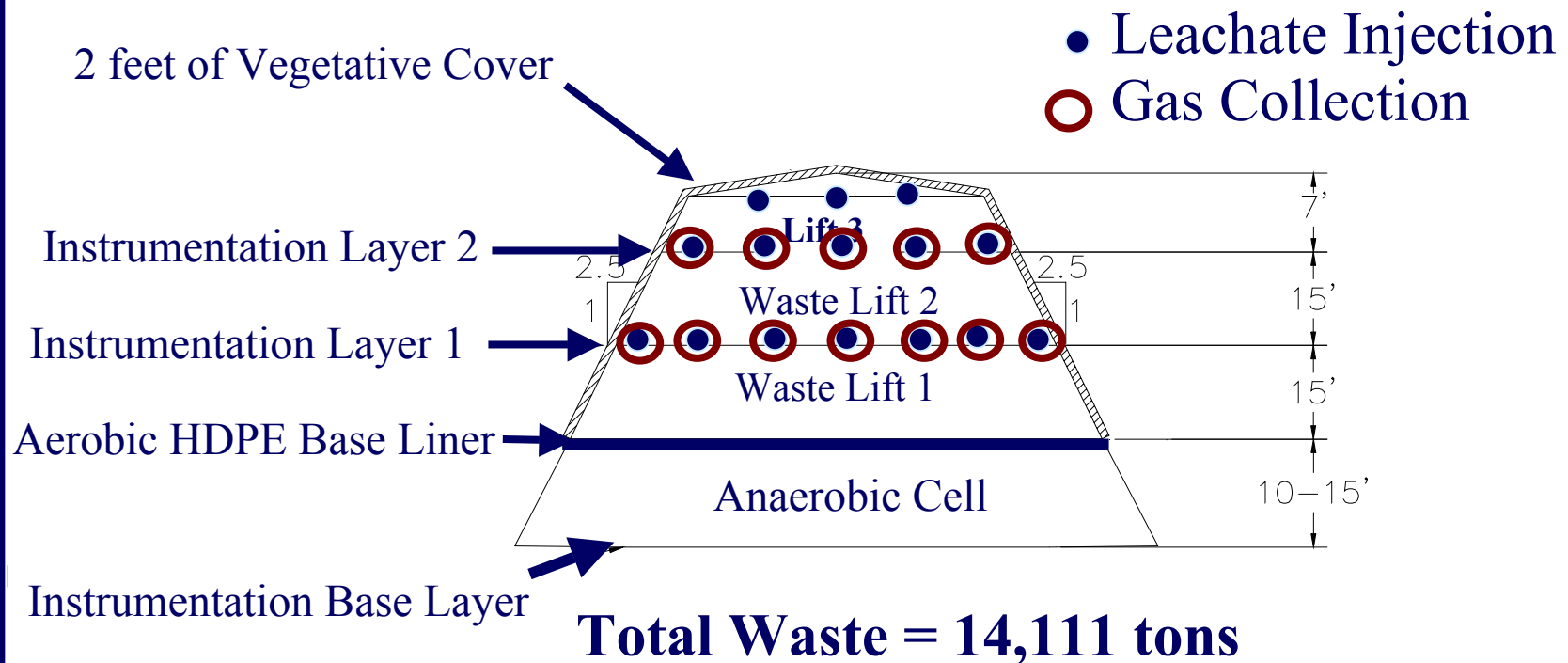
## ■ Northeast 3.5-acre anaerobic cell x-section



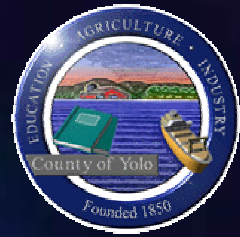


# Achievements to Date

## ■ Southeast 2.5-acre aerobic cell x-section

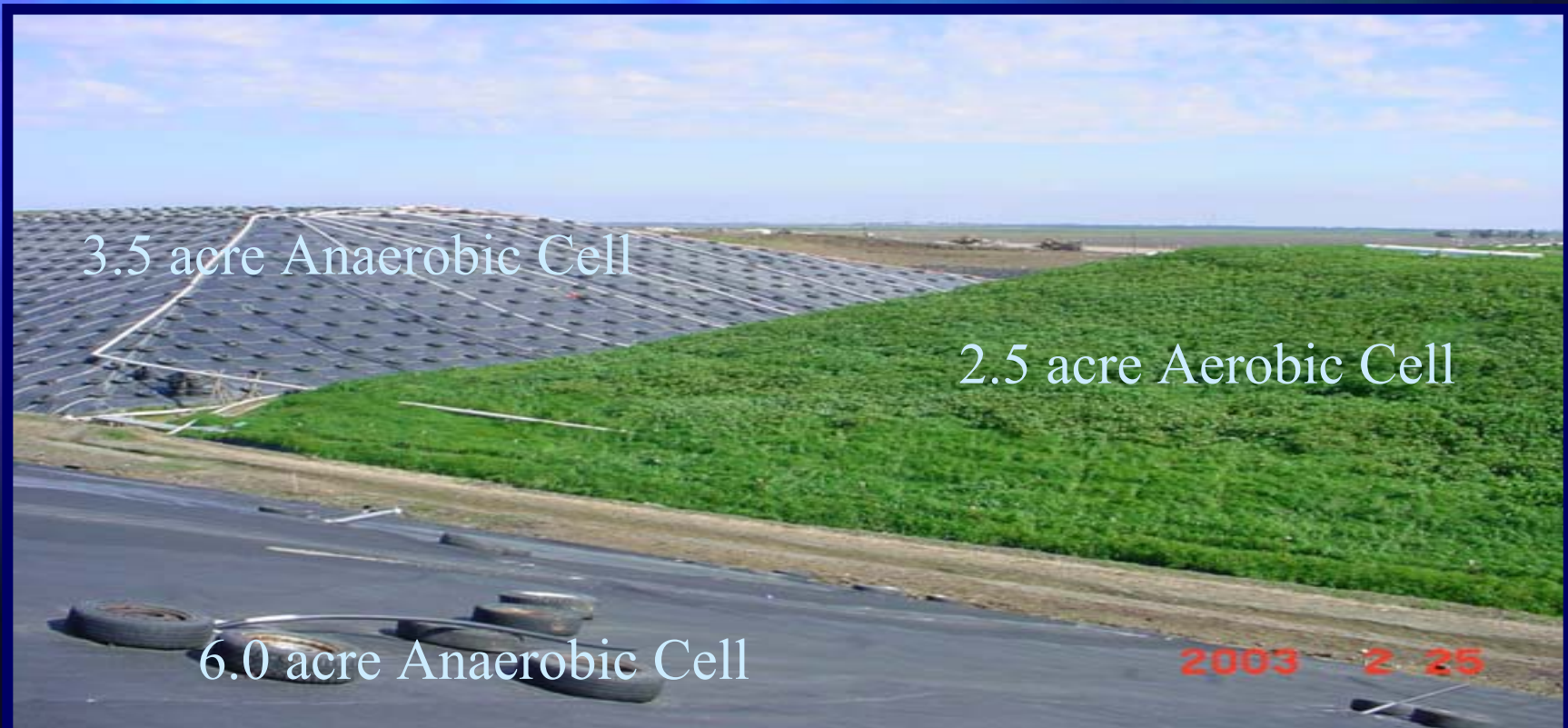


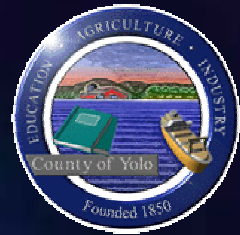




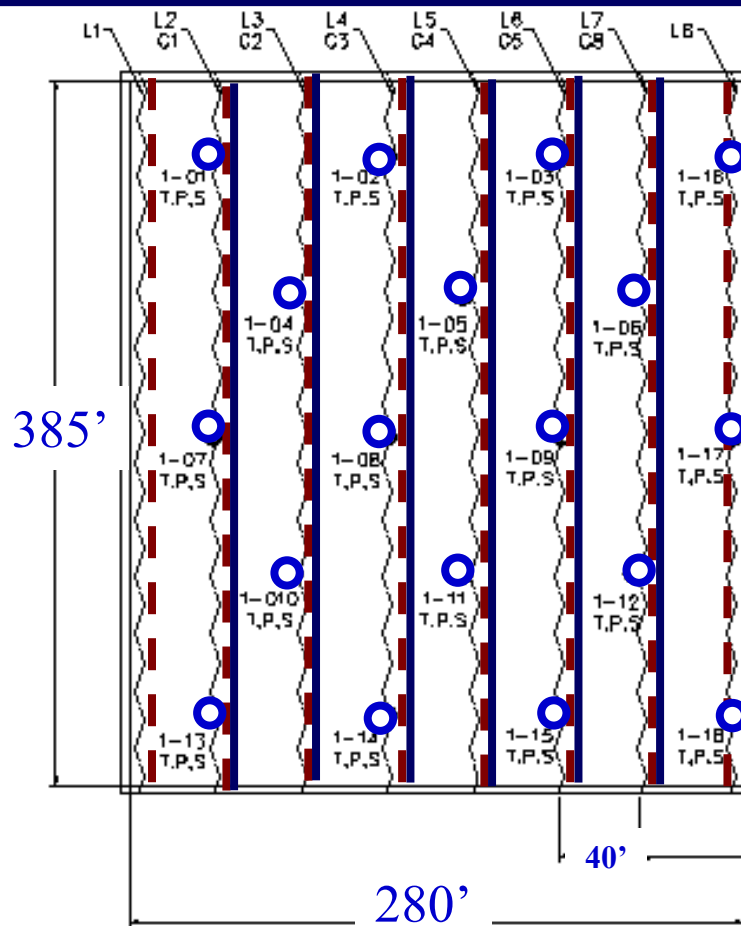
# Achievements to Date

## ■ Southeast 2.5-acre aerobic cell x-section





# Achievements to Date



## Layer 1 - (3.5-acre) Instrumentation, Leachate Injection, and Gas Collection System

### LEGEND

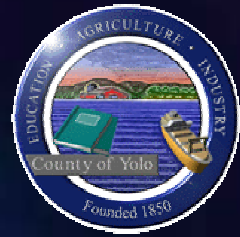
T = Temperature

P = PVC Moisture Sensor

S = Sampling Tubes

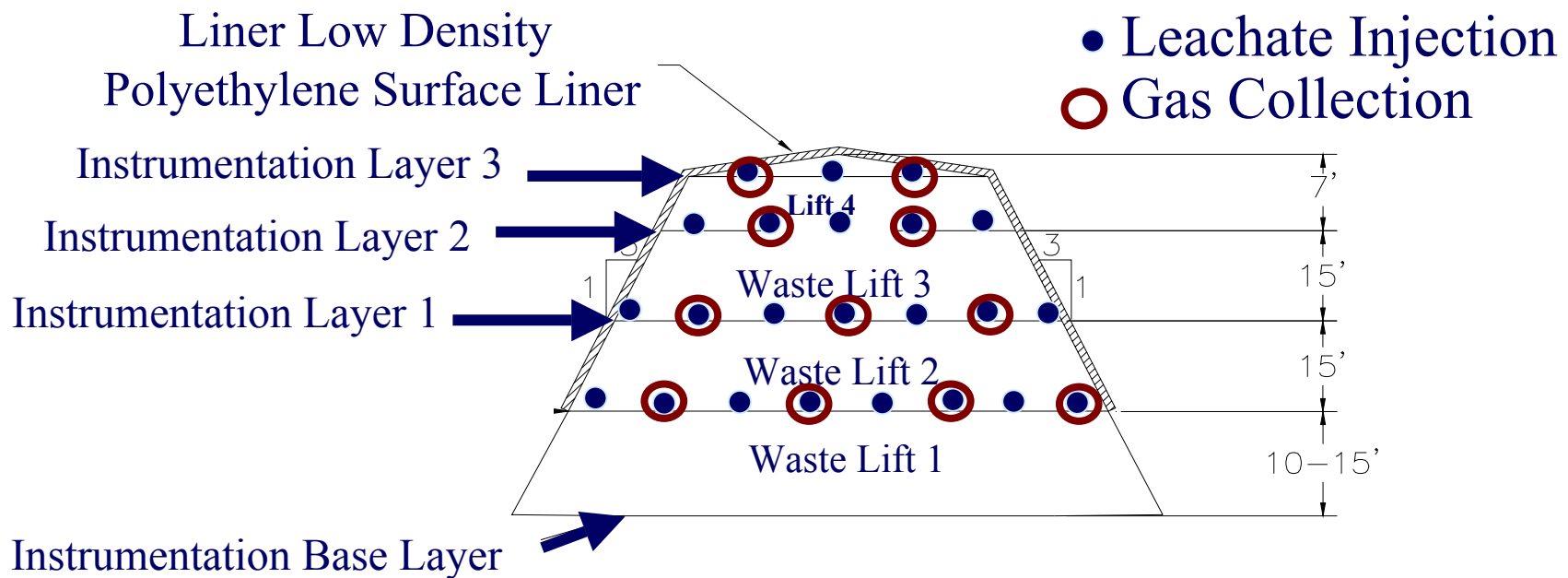
G = Gas Collection Line Number on Layer 1

L = Liquid Addition Line Number on Layer 1



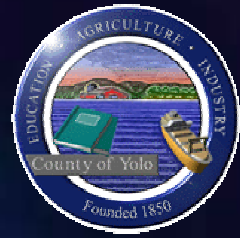
# Achievements to Date

## ■ West 6-acre anaerobic cell



**Total Waste = 193,852 tons**





# Achievements to Date

- Construction of landfill gas collection and removal system





# Achievements to Date

- Construction of leachate recirculation and pumping system





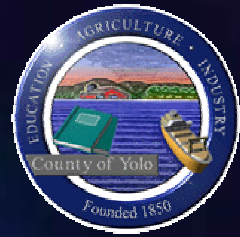


# Achievements to Date

- Construction of leachate injection lines





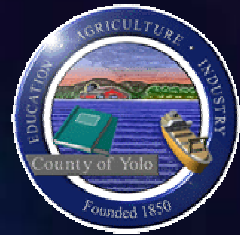


# Achievements to Date

## ■ Construction of cover system

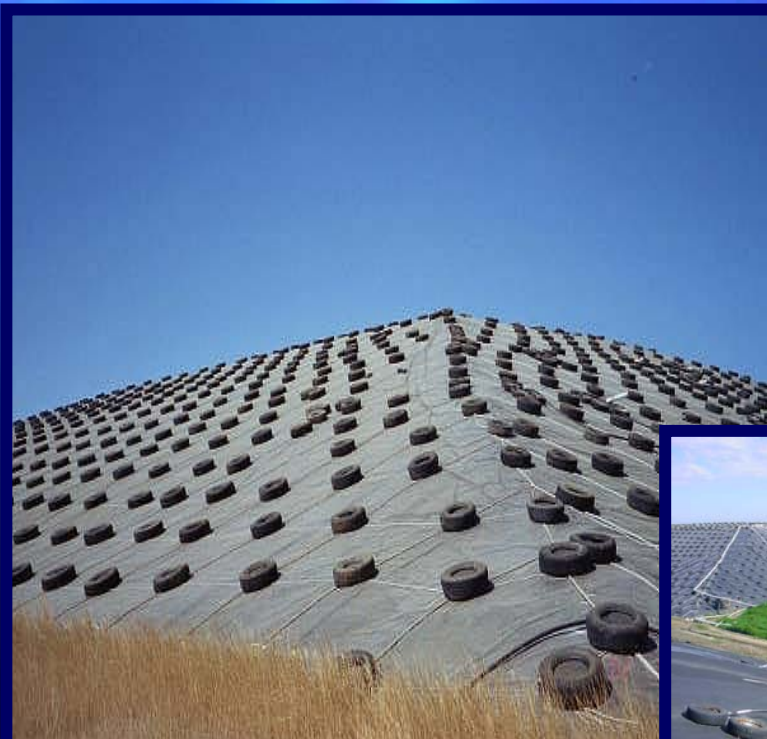






# Achievements to Date

## ■ Construction of cover system





# Achievements to Date

## ■ Aerobic Blower and Biofilter System







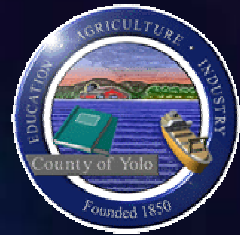
# Achievements to Date



## ■ Construction of the SCADA System

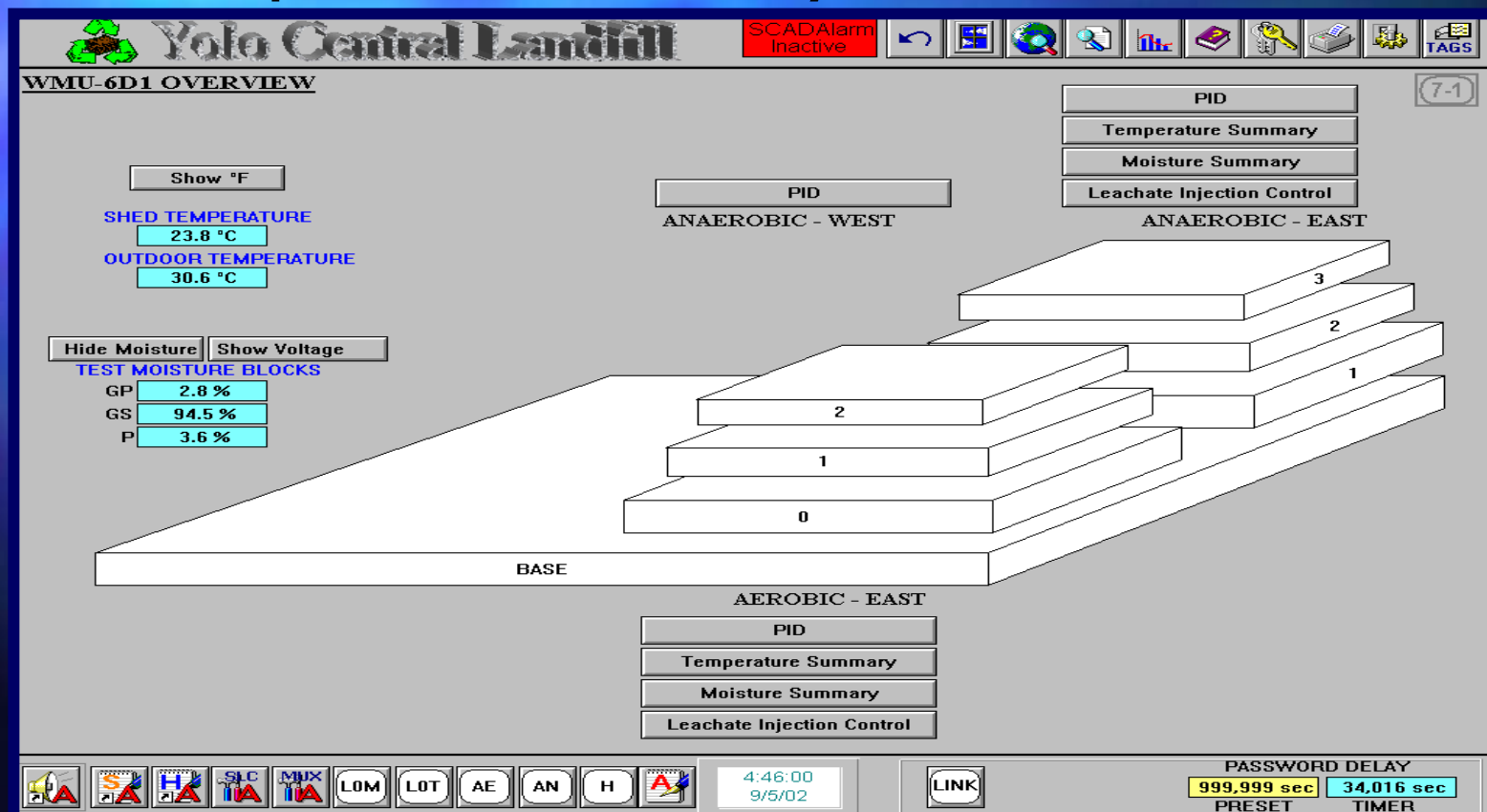


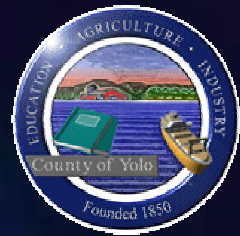




# Achievements to Date

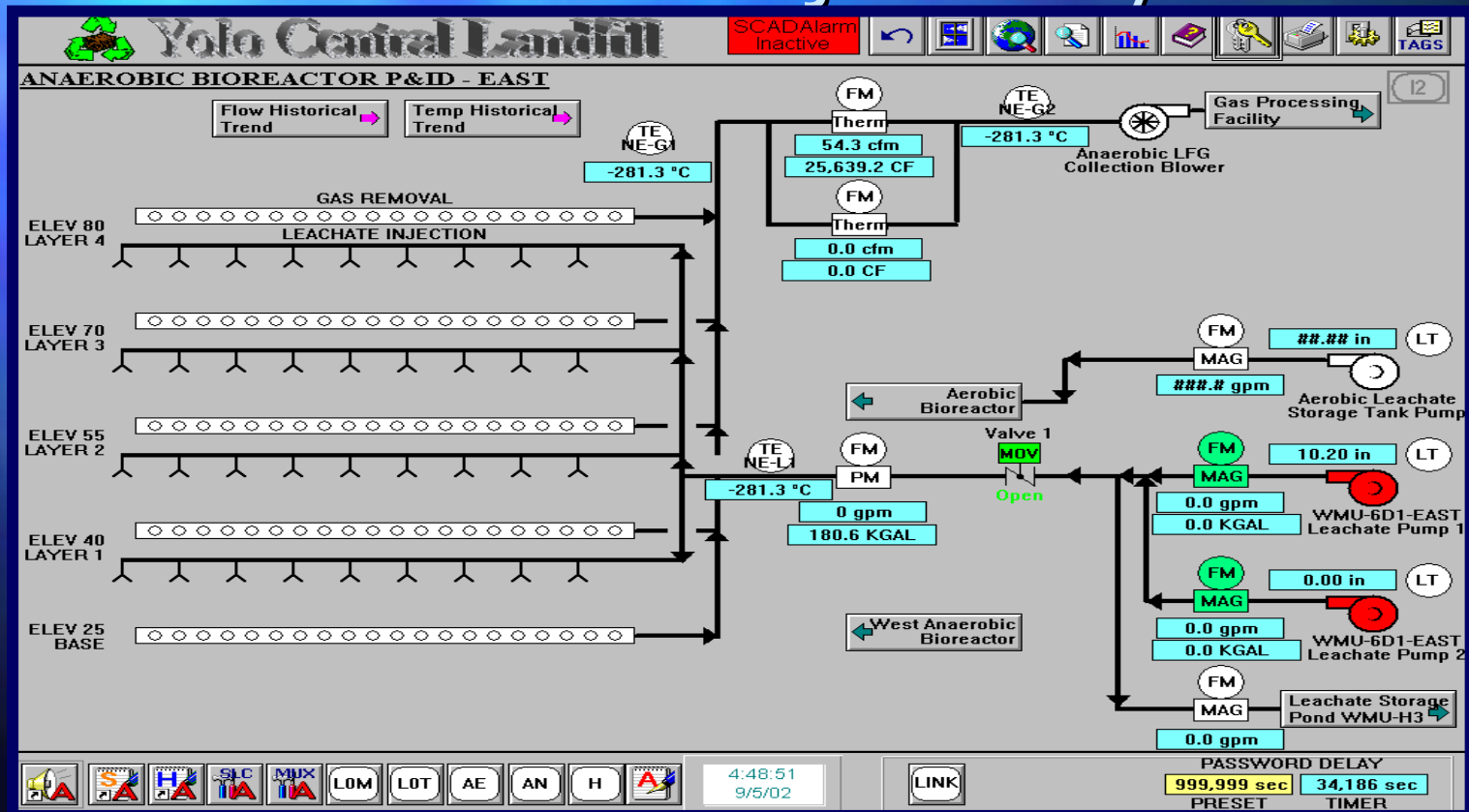
## ■ Computer SCADA System

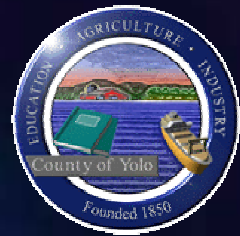




# Achievements to Date

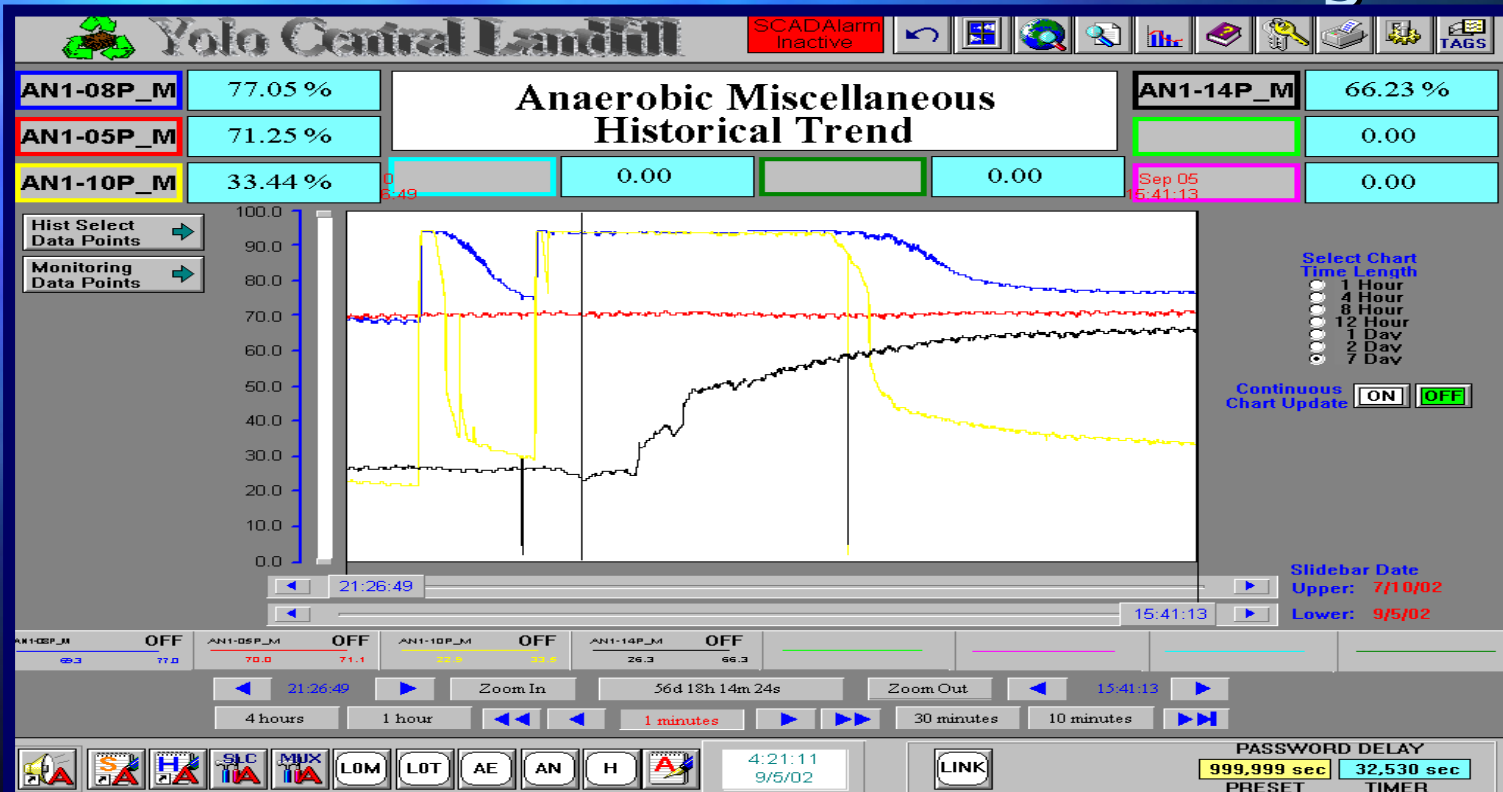
## ■ SCADA- Leachate Injection System



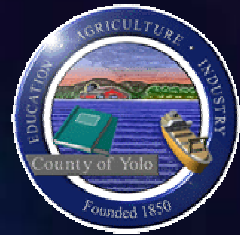


# Achievements to Date

## ■ SCADA- Real time data monitoring







# Achievements to Date

## ■ SCADA- Leachate Injection System Control

**Yolo Central Landfill** SCADA Alarm Inactive

**ANAEROBIC LEACHATE INJECTION CONTROL A** Layer 3 & 4 Control Max # of Solenoid Valves Open at any Time **1**

LAYER 1					
	Call	Enable/Disable	Schedule A Start Time	Schedule B Start Time	Schedule A&B Duration
Valve 1	Close	En Dis	0:00	0:00	0 min
Valve 2	Close	En Dis	0:00	0:00	0 min
Valve 3	Close	En Dis	0:00	0:00	0 min
Valve 4	Close	En Dis	0:00	0:00	0 min
Valve 5	Close	En Dis	0:00	0:00	0 min
Valve 6	Close	En Dis	0:00	0:00	0 min
Valve 7	Close	En Dis	0:00	0:00	0 min
Valve 8	Close	En Dis	0:00	0:00	0 min

Central Control			
Auto/Manual	Manual On/Off	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF

LAYER 2					
	Call	Enable/Disable	Schedule A Start Time	Schedule B Start Time	Schedule A&B Duration
Valve 1	Close	En Dis	0:00	0:00	0 min
Valve 2	Close	En Dis	0:00	0:00	0 min
Valve 3	Close	En Dis	0:00	0:00	0 min
Valve 4	Close	En Dis	0:00	0:00	0 min
Valve 5	Close	En Dis	0:00	0:00	0 min
Valve 6	Close	En Dis	0:00	0:00	0 min
Valve 7	Close	En Dis	0:00	0:00	0 min

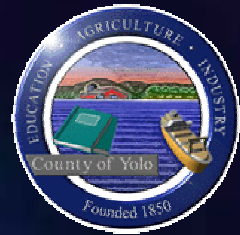
Central Control			
Auto/Manual	Manual On/Off	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF
Auto	Manual	ON	OFF

SLC Time 0:00

4:47:01 9/5/02

LINK

PASSWORD DELAY  
999,999 sec PRESET 34,077 sec TIMER



# Achievements to Date

## ■ SCADA- Data export to database

**Yolo Central Landfill** SCADA Alarm Inactive

**HISTORICAL DATA EXPORT B - ANAEROBIC TEMP**

Base Layer Historical Dump Anaerobic Moist Historical Dump

Press Button to Select Tagnames

1. **Start Date**  
Year has to be between 1997 and 2030!  
Month: 09, Day: 04, Year: 2002  
Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec

2. **Duration Time**  
5  
Seconds, Minutes, Hours, Days, Weeks  
[ex. 31 days for January]

3. **Interval Time**  
1  
Seconds, Minutes, Hours, Days, Weeks  
Max 4 Weeks  
[ex. every 5 minutes]

4. **Start Time**  
5:00 p.m.

5. **Filename** (8 Letter Max)  
C:\TEMP\ZTEMP.CSV

**Setup Summary**

Start Date	Start Time	Duration	Interval
09/04/02	17:00:00	5m	1m

tags selected 0  
"SDATE,STIME"  
...

6. **Tagnames**  
AN1-01T °C, AN1-11T °C, AN2-01T °C, AN2-11T °C, AN3-01T °C, AN3-11T °C  
AN1-02T °C, AN1-12T °C, AN2-02T °C, AN2-12AT °C, AN3-02T °C, AN3-12T °C  
AN1-03T °C, AN1-13T °C, AN2-03T °C, AN2-12BT °C, AN3-03T °C, AN3-13T °C  
AN1-04T °C, AN1-14T °C, AN2-04T °C, AN2-13T °C, AN3-04T °C  
AN1-05T °C, AN1-15T °C, AN2-05T °C, AN2-14T °C, AN3-05T °C  
AN1-06T °C, AN1-16T °C, AN2-06T °C, AN2-15T °C, AN3-06T °C  
AN1-07T °C, AN1-17T °C, AN2-07T °C, AN3-07T °C  
AN1-08T °C, AN1-18T °C, AN2-08T °C, AN3-08T °C  
AN1-09T °C, AN2-09T °C, AN3-09T °C  
AN1-10T °C, AN2-10T °C, AN3-10T °C

7. **EXPORT** 8. **RESET**

**EXPORT HISTORICAL FILES**  
1. SELECT START DATE (MONTH, DATE, YEAR).  
2. SELECT DURATION TIME UNITS, THEN TIME.  
3. SELECT INTERVAL TIME UNITS, THEN TIME.  
4. SELECT START TIME.  
5. SELECT DIRECTORY & FILENAME TO SAVE TO.  
6. SELECT TAGNAMES TO EXPORT. (8 MAX).  
7. PRESS "EXPORT" BUTTON.  
8. TO CLEAR SELECTED TAGS, PRESS "RESET".

4:49:54 9/5/02 LINK

PASSWORD DELAY  
999,999 sec PRESET 34,249 sec TIMER



# Achievements to Date

- First waste sampling and BMP testing







# Achievements to Date

- First & second waste settlement survey

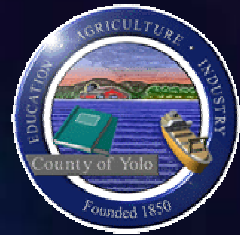


# Achievements to Date

- Fugitive methane emissions monitoring using FID/PID Vapor Analyzer (FOXBORO TVA-1000)





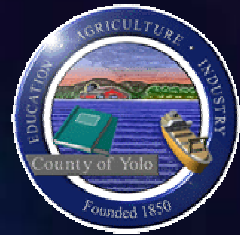


# Achievements to Date

- Landfill gas sampling (LANDTECH GEM-500) and laboratory testing
- Leachate sampling and laboratory testing

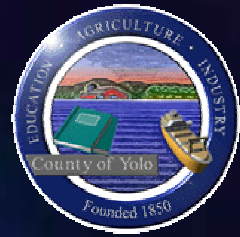






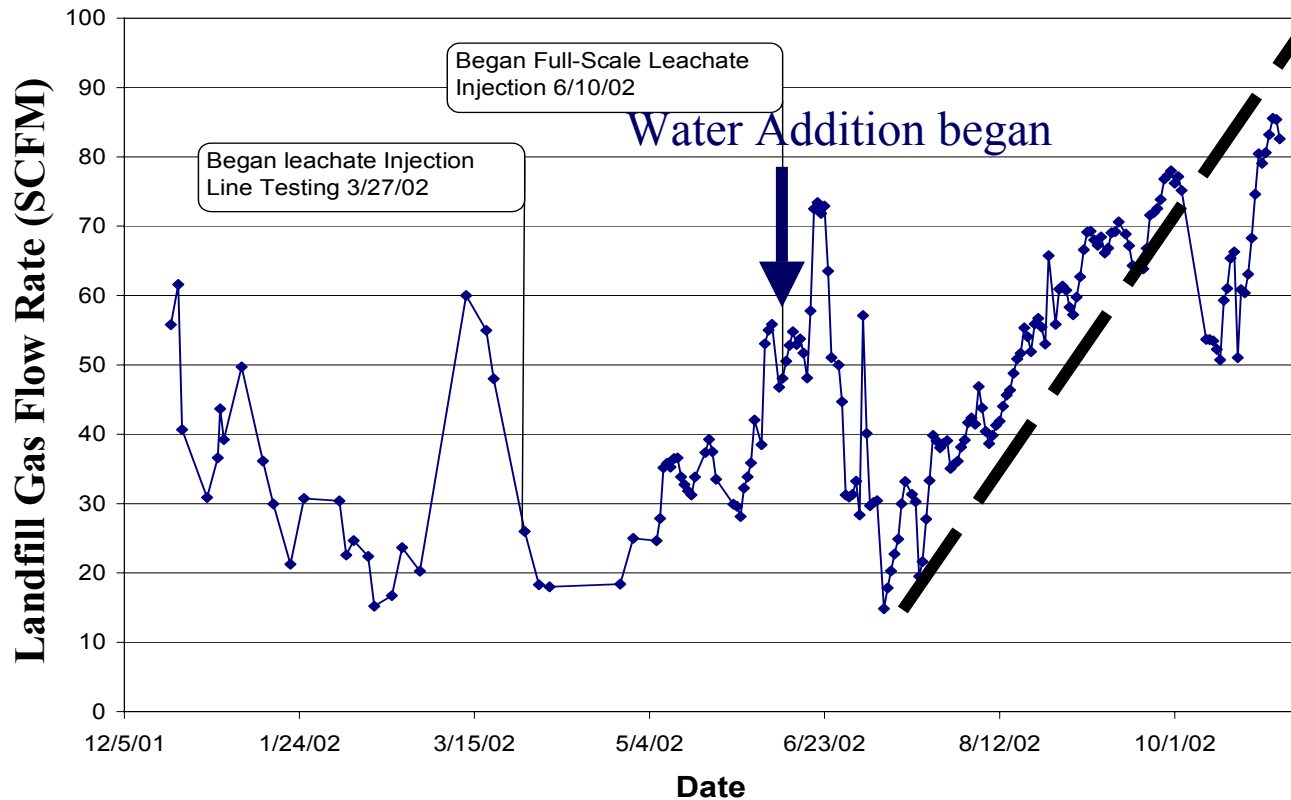
# Full-scale project results

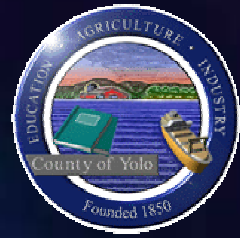




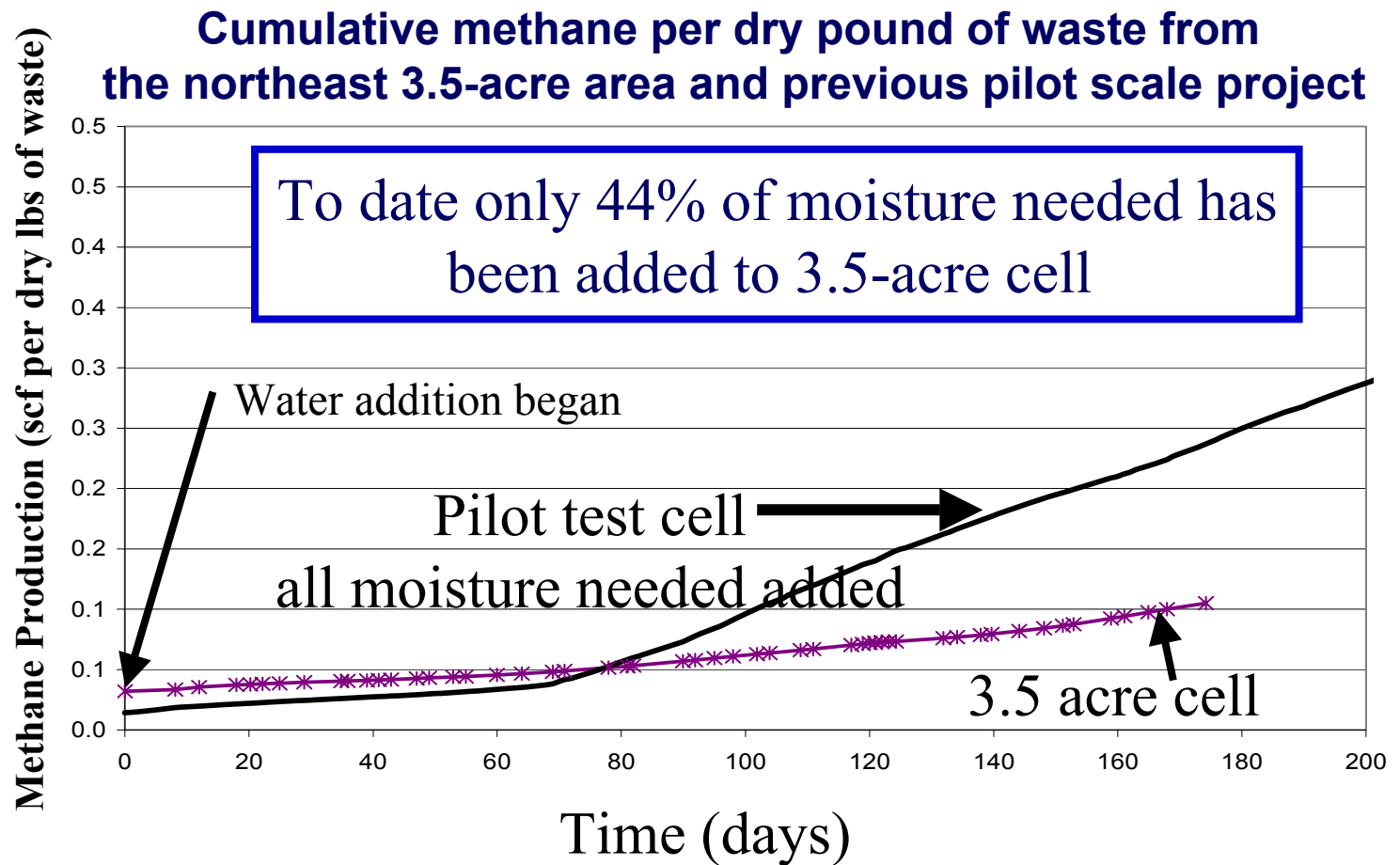
# Full-Scale Project Results

**Landfill gas flow rate from main landfill gas header line for northeast 3.5-acre bioreactor**

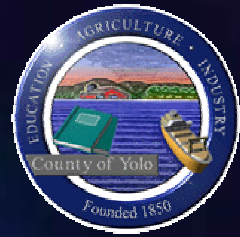




# Full-scale Project Results

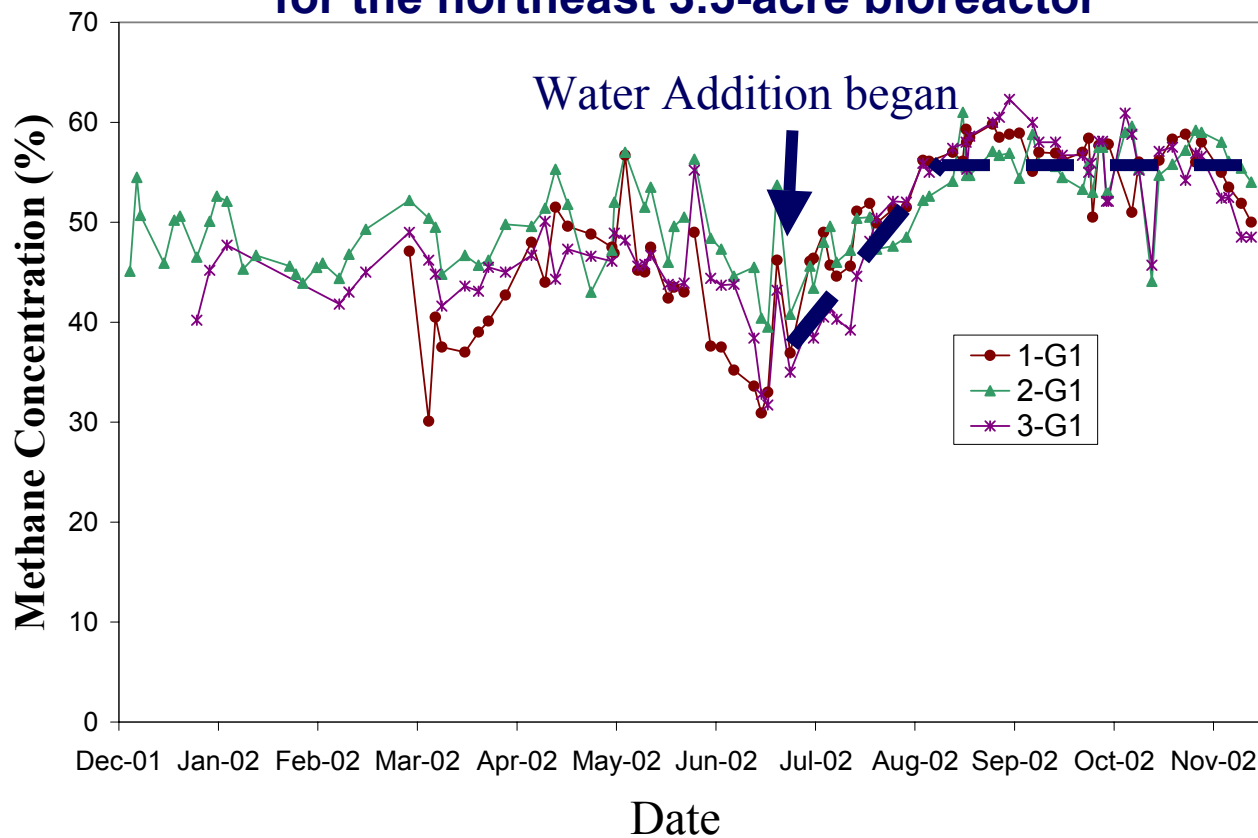


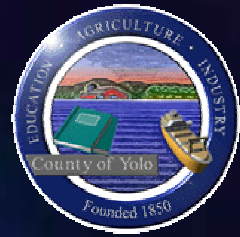




# Full-scale Project Results

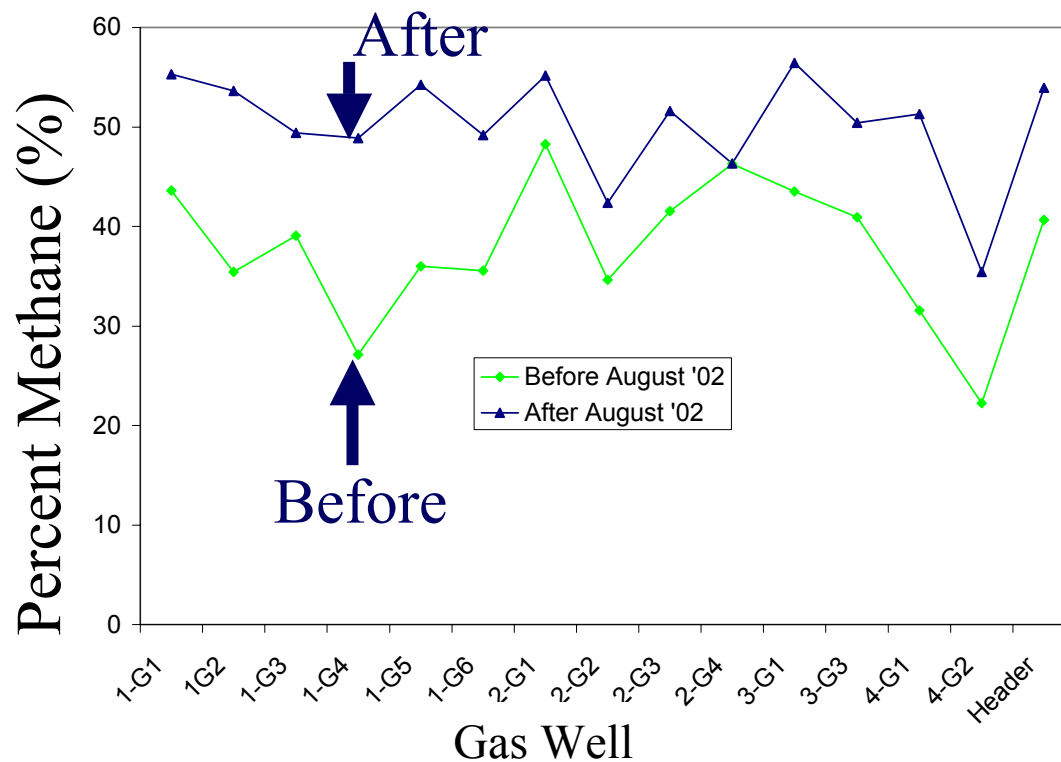
**Methane Concentration of three selected gas wells  
for the northeast 3.5-acre bioreactor**

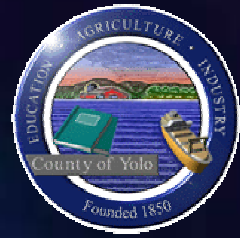




# Full-scale Project Results

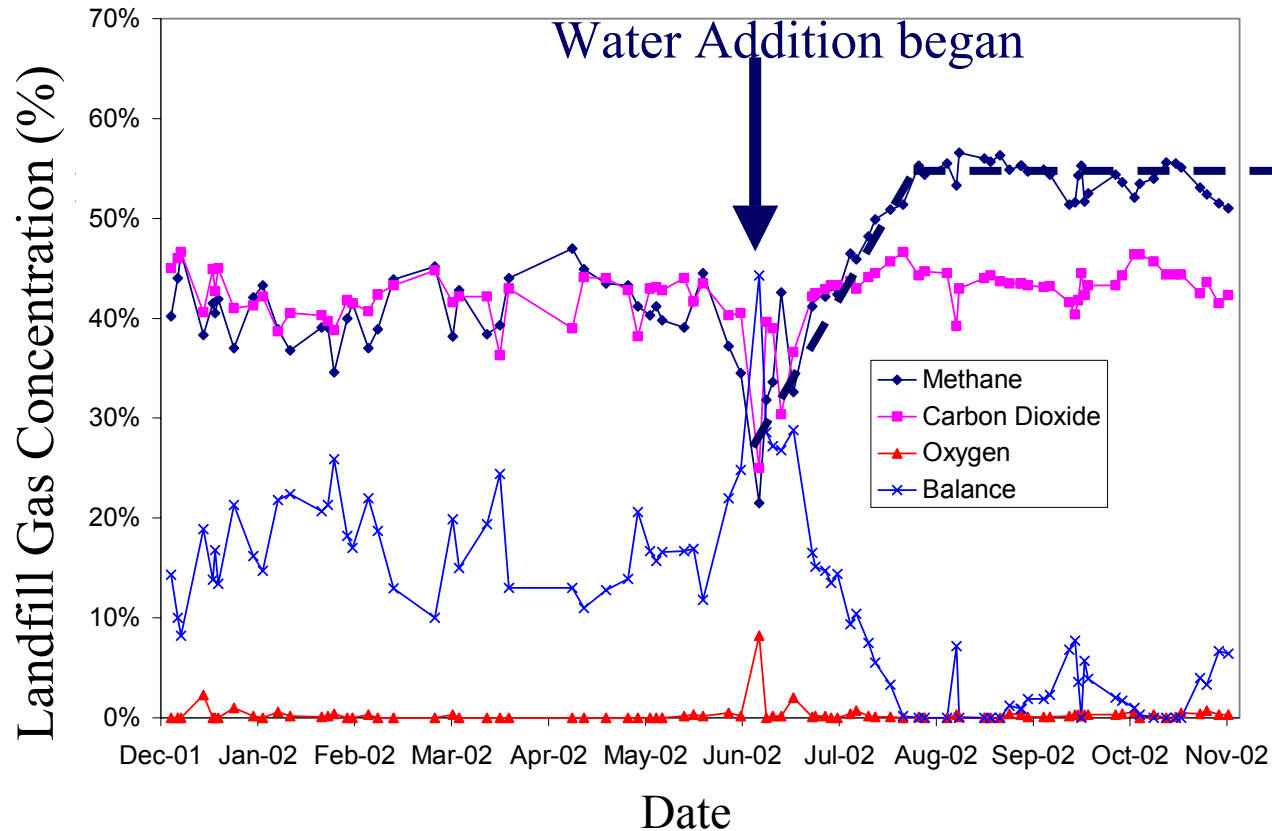
**Average methane concentration of each individual gas wells before and after leachate addition (3.5-acre cell)**



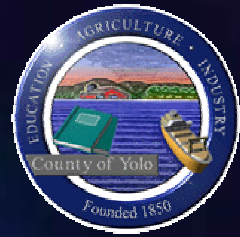


# Full-scale Project Results

**Landfill gas concentrations from gas header line for northeast 3.5-acre cell**

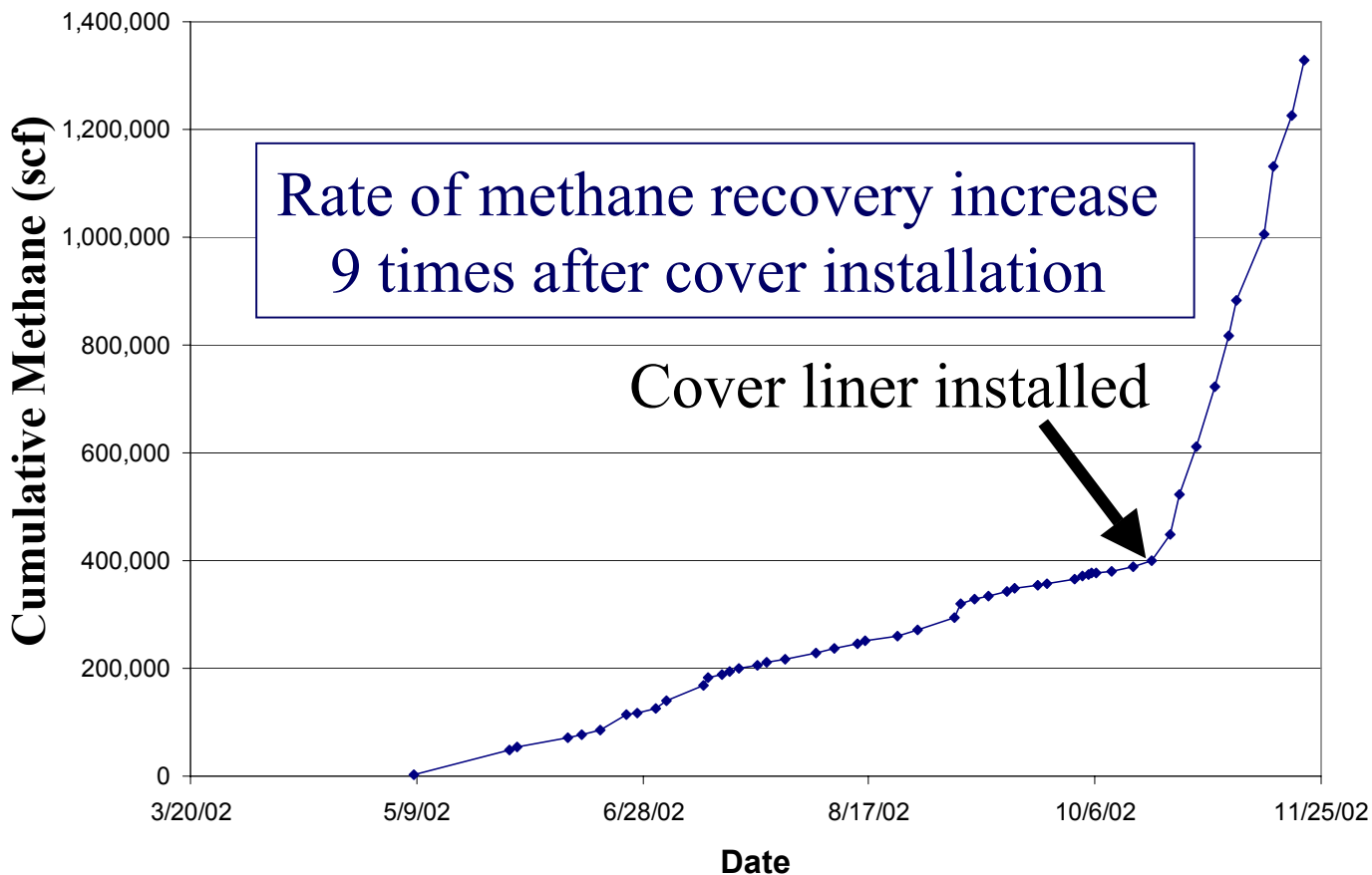






# Full-scale Project Results

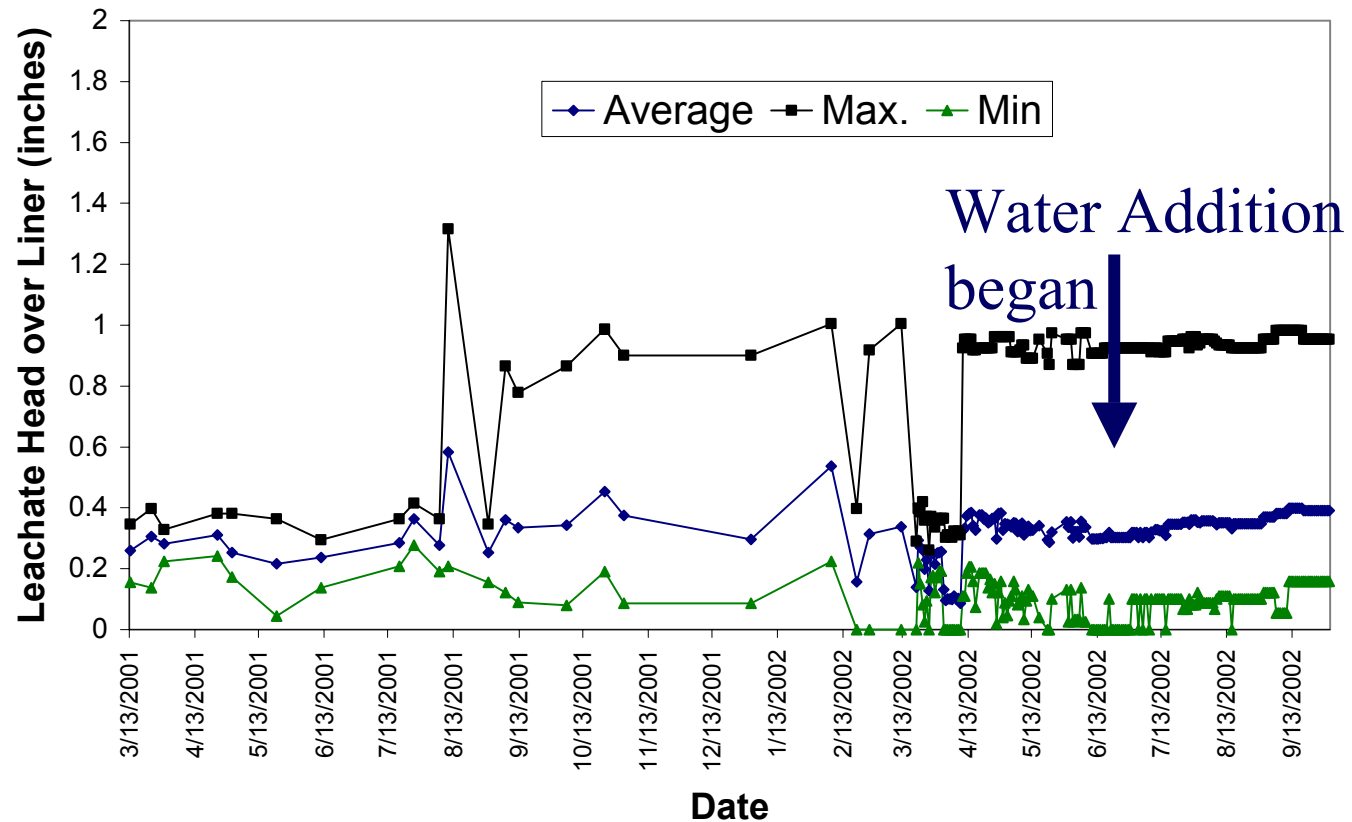
**Cumulative methane production from  
the west 6-acre area**

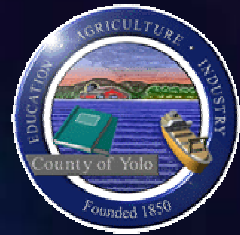




# Full-scale Project Results

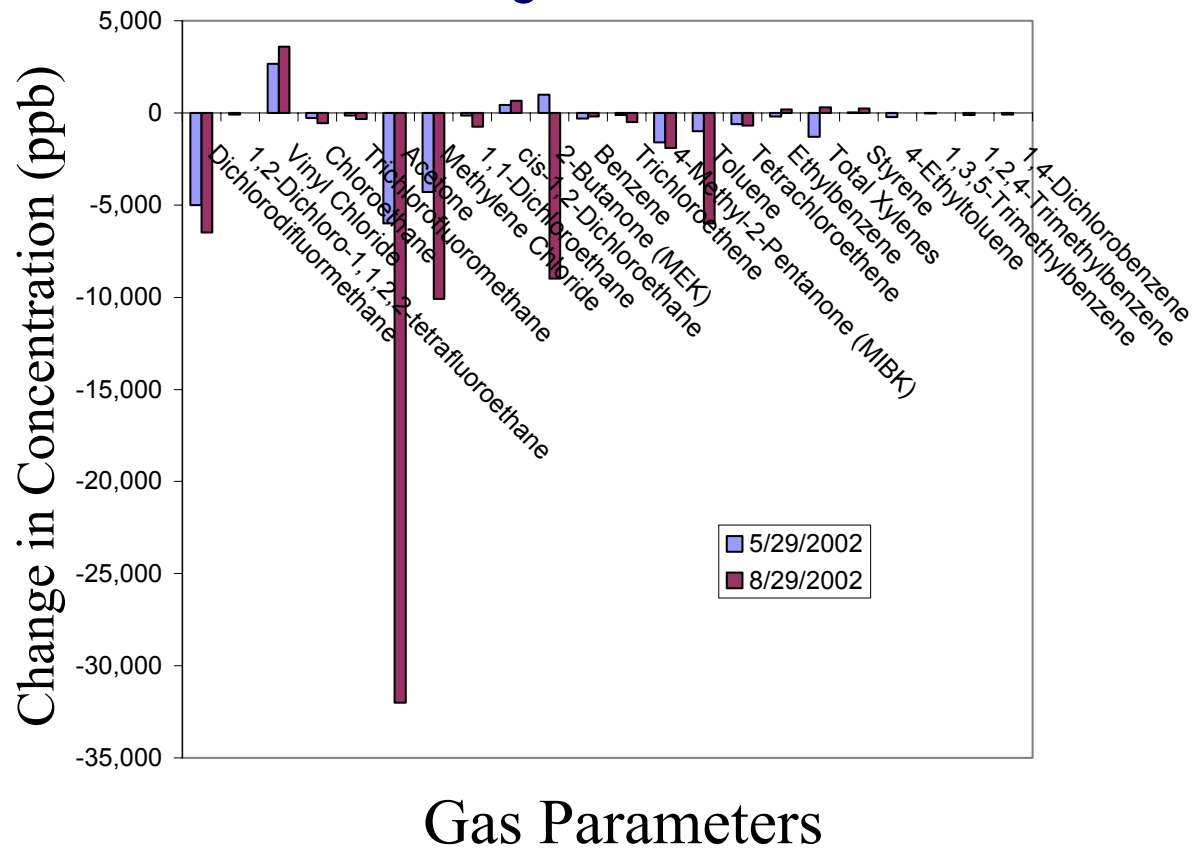
Leachate head over the liner for the full-scale bioreactor project





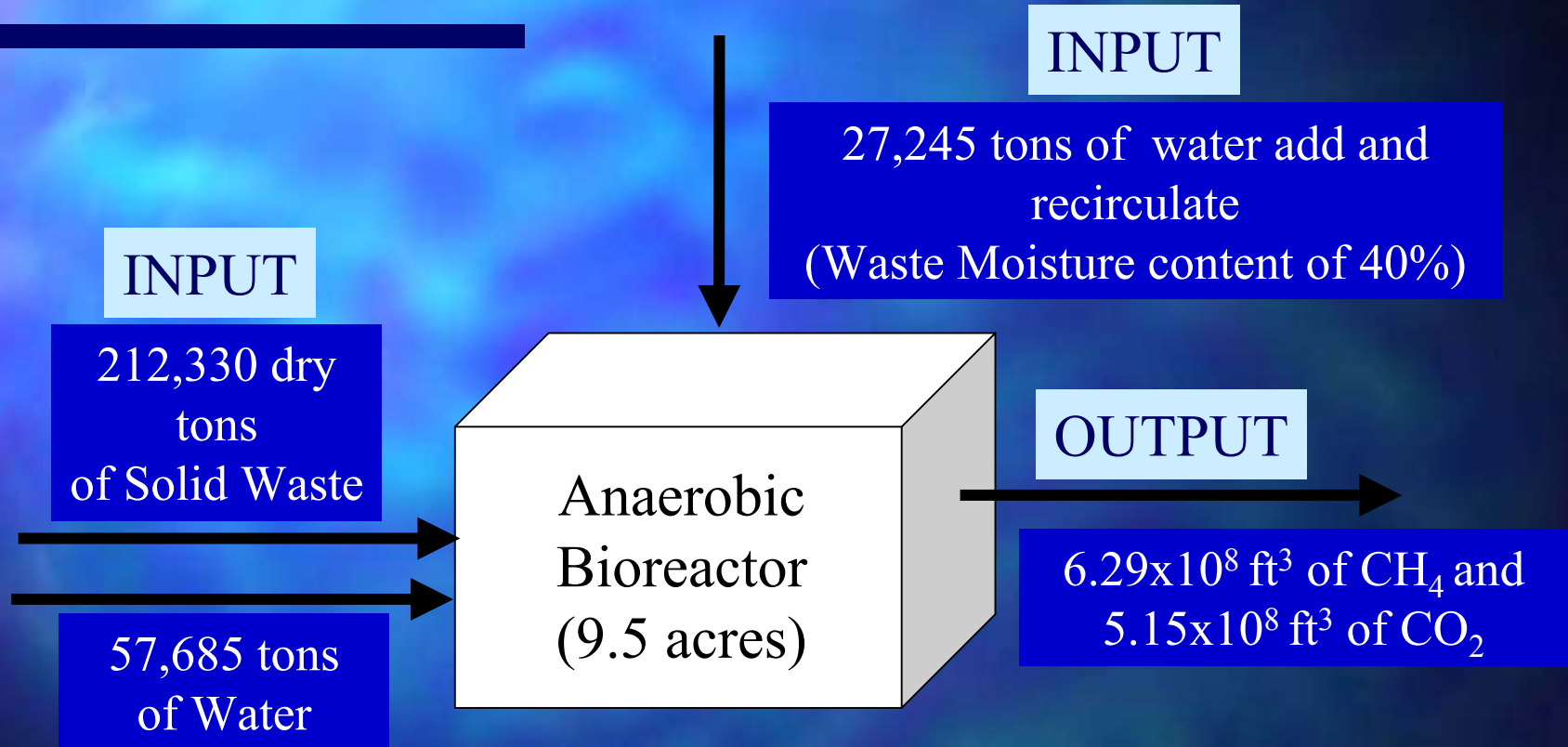
# Full-Scale Project Results

## Reduction in landfill gas constituent concentration

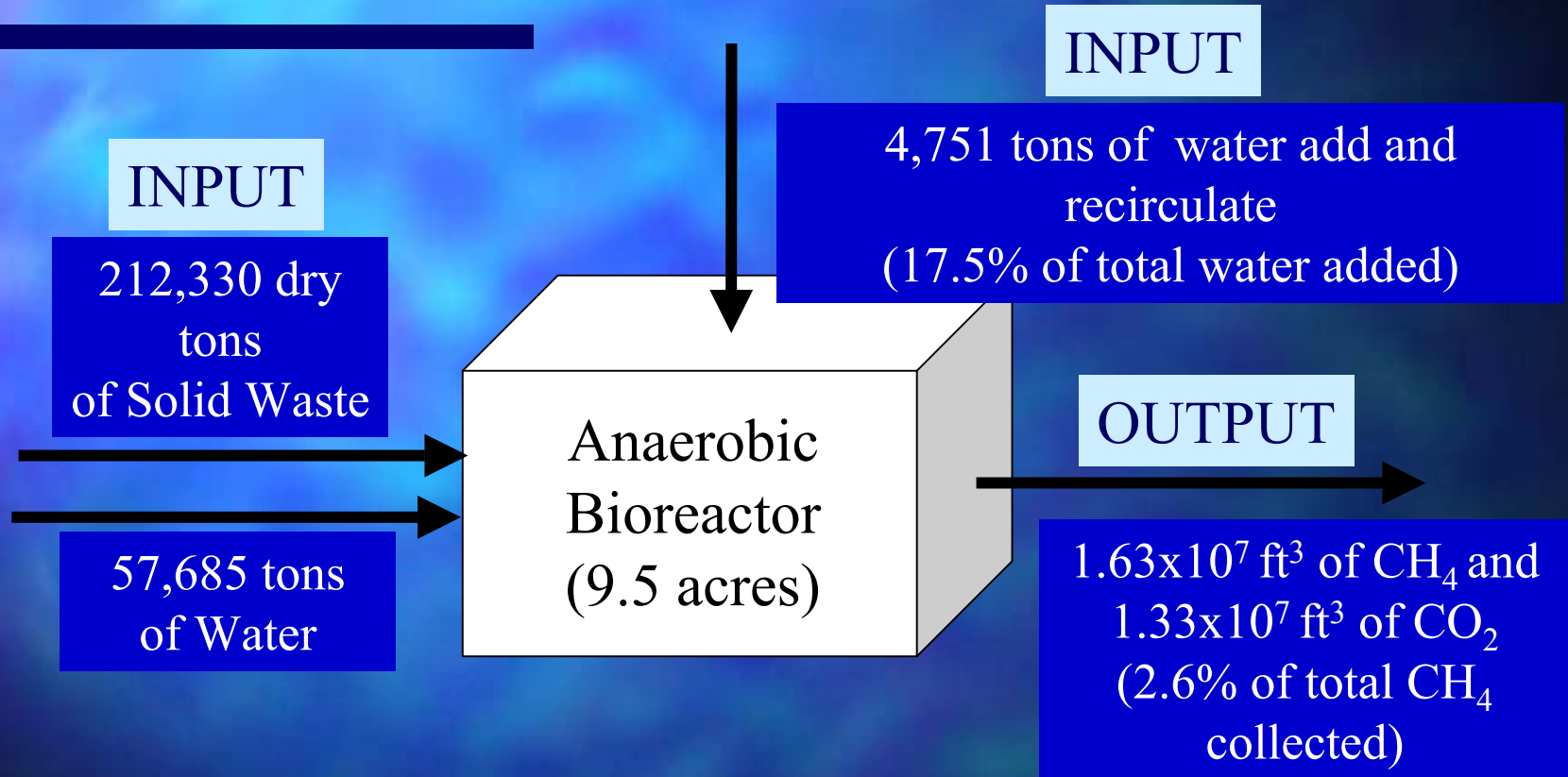




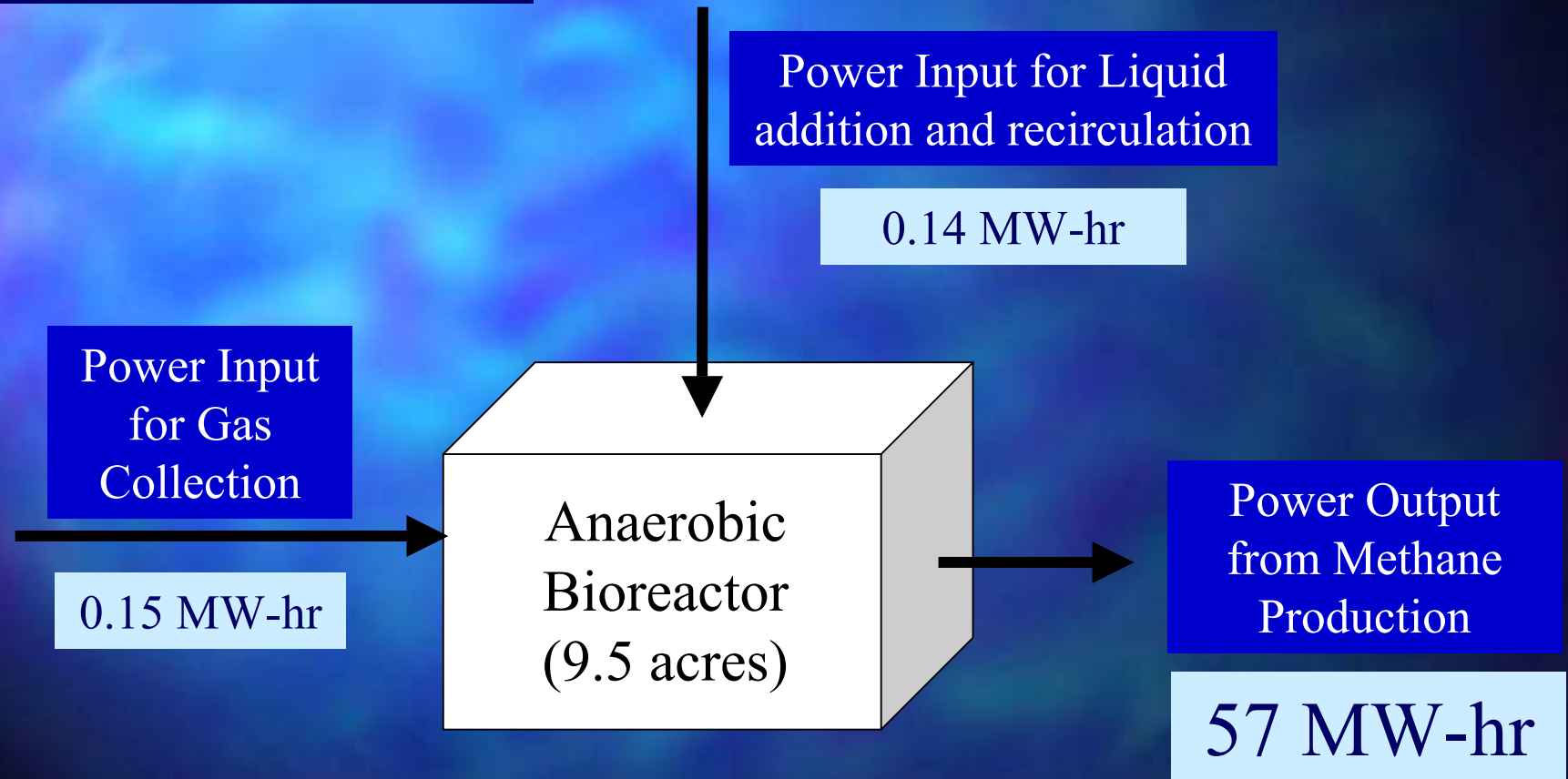
# Total Mass Balance for Anaerobic Bioreactor



# Current Mass Balance for Anaerobic Bioreactor

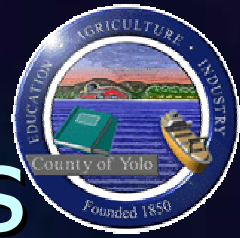


# Total Energy Balance for Anaerobic Bioreactor



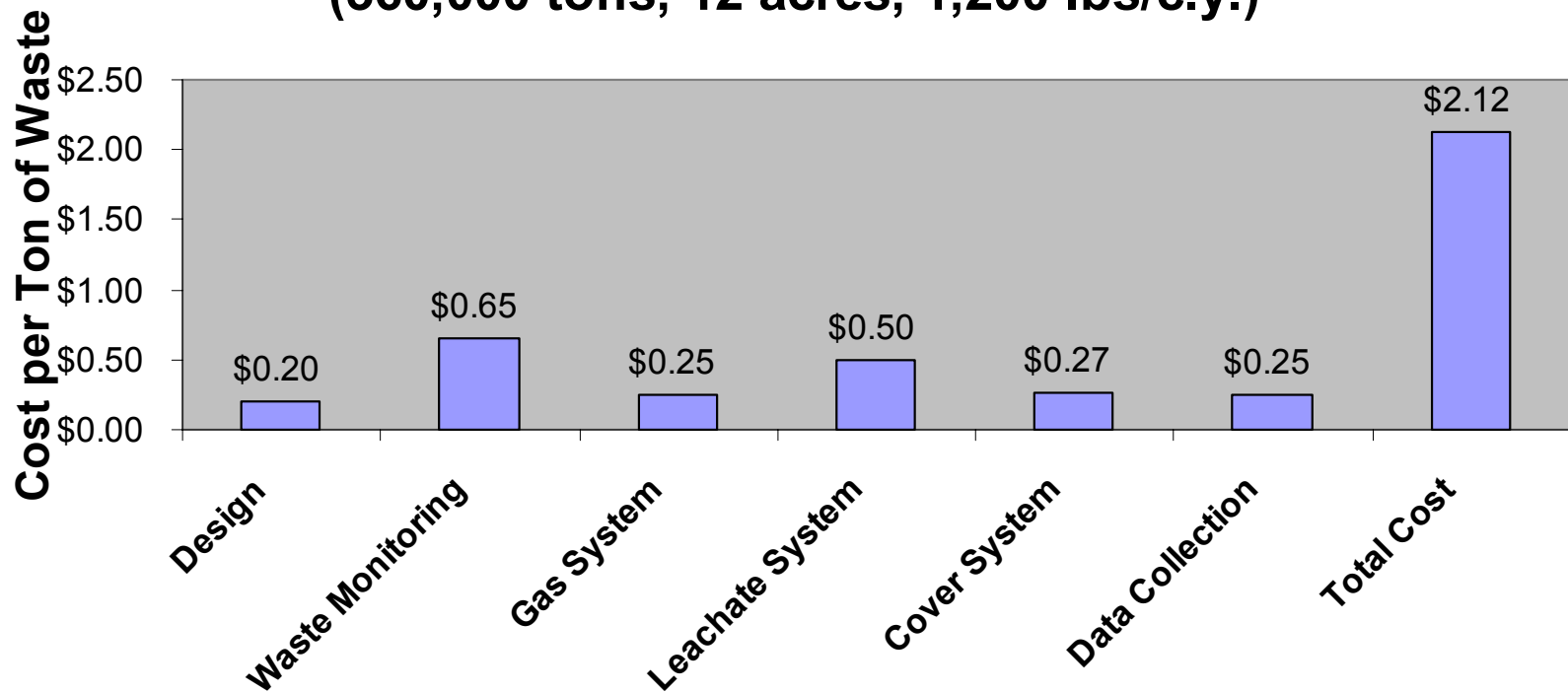
Parasitic Losses = 0.51%  $\sim$  < 1 %

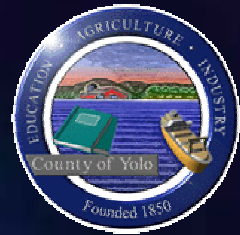




# Full-scale Project Economics

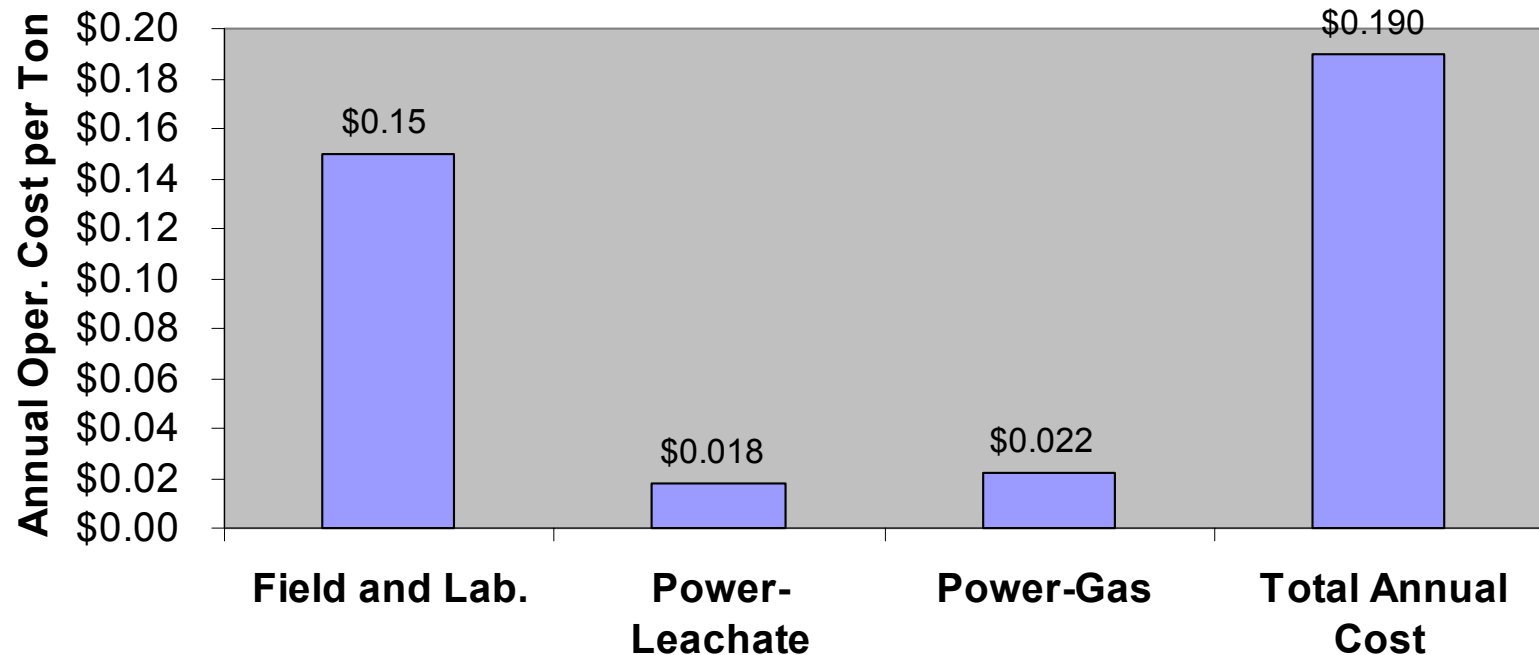
**Capital Cost per Ton of Waste  
(360,000 tons, 12 acres, 1,200 lbs/c.y.)**

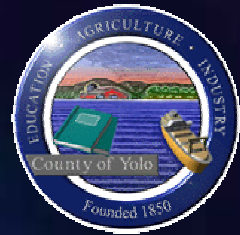




# Full-scale Project Economics

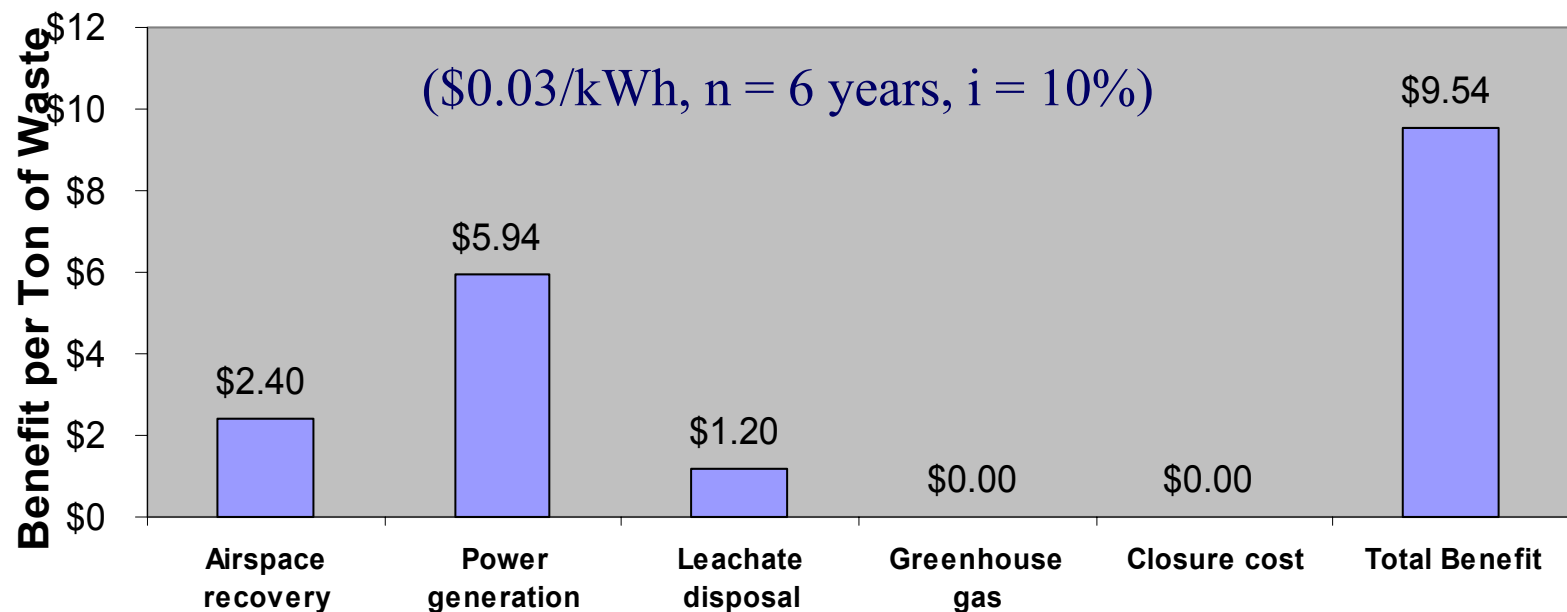
**Annual Operating Cost per Ton of Waste  
(360,000 tons, 12 acres, 1,200 lbs/c.y.)**



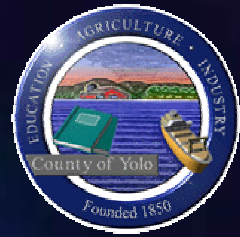


# Full-scale Project Economics

**Total Benefit per Ton of Waste**  
(360,000 tons, 12 acres, 1,200 lbs/c.y.)

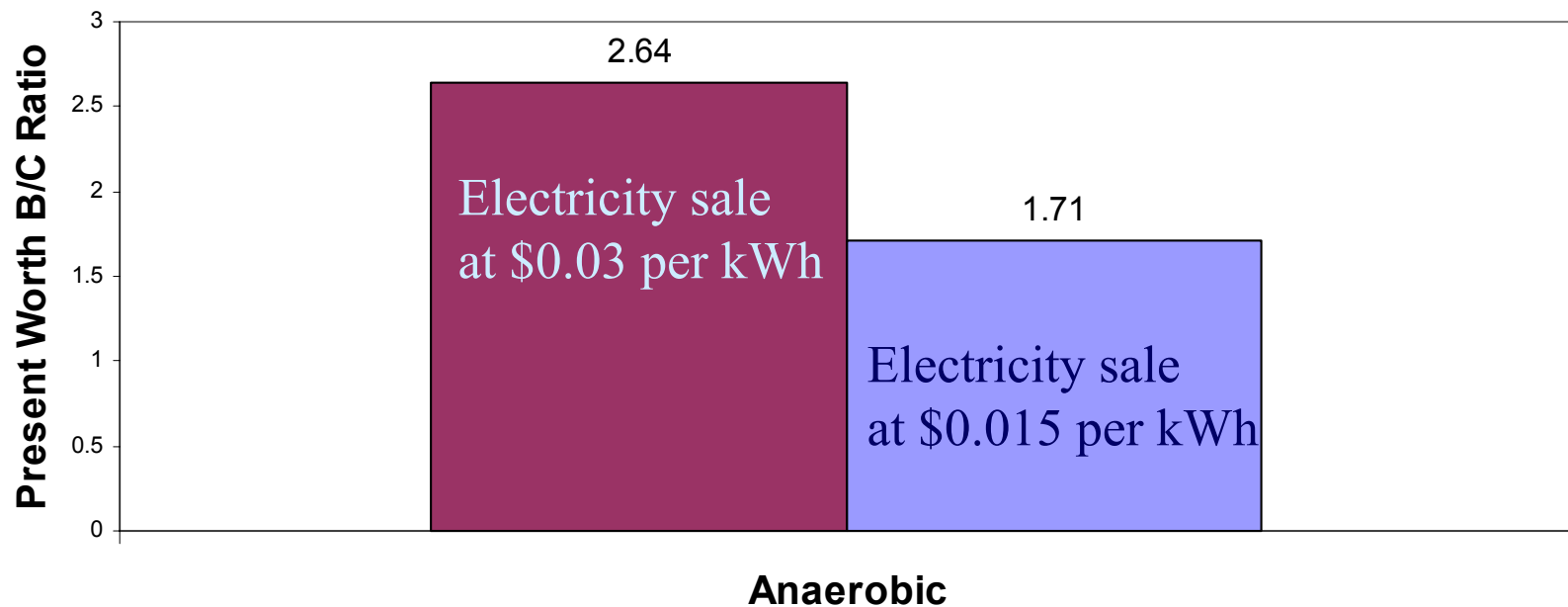


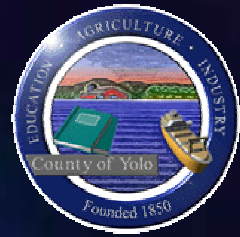




# Full-scale Project Economics

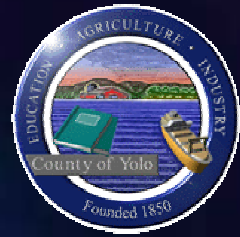
**Present Worth Benefit Cost Ratio  
(360,000 tons, 12 acres, 1,200 lbs/c.y.)**





# Design, Construction, and Operation Challenges

- Liner cap design and construction
- Installation of instrumentation after waste filling
- Securing installed liner and penetration of pipes through the cap
- Leachate injection system & precipitation of calcium carbonate
- HDPE Injection lines-drilling and installing fittings
- Pressurized (liquid) Leachate injection system-inspection for leaks

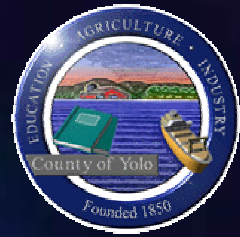


# Conclusions

## ■ Bioreactors can:

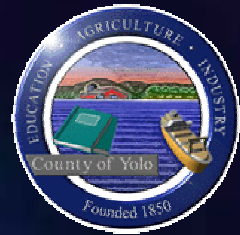
- Be constructed with normal landfill equipments
- Be operated in a safe manner
- Be instrumented during waste filling phase
- Collect landfill gas under cover to reduce fugitive emissions via horizontal gas collection system
- Be operated to slowly inject leachate and prevent hydrostatic head build up over the base liner





# Conclusions

- Bioreactors can:
  - Be operated to inject leachate horizontally to distribute moisture uniformly
  - Be designed to be operated by a SCADA system
  - Be designed Collect real-time field data for monitoring, control, and data collection
  - Be have a master database for data management and reporting
  - Be economical to construct and operate



# THE END

QUESTIONS?

***Thank  
You!***

